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THE EFFECTS OF VARYING AMOUNTS OF EXCHANGEABLE BASES ON THE YIELD AND ON THE LIME AND PHOSPHORIC ACID CONTENTS OF LETTUCE [1]

JORGE G. DAVIDE AND N. L. GALVEZ

WITH TWO TEXT FIGURES

King and Guanzon (1929), Aquino (1936), and Galvez and Aquino (1951) have done some work on the exchangeable bases of some Philippine soils. These authors, however, barely touched on the relation of exchangeable bases to the yield and chemical constituents of plants grown in pots. For this reason, the effects of varying amounts of exchangeable bases on the yield and on the lime and phosphoric acid contents of lettuce plants were studied in the Department of Soils from October, 1949, to February, 1951.

REVIEW OF LITERATURE

According to Peech and Bradfield (1943), Van Itallie in 1938 showed that in soils with variable exchangeable cations, the mutual cation replacement takes place in the plant in nearly equivalent amounts. The largest amount absorbed is potassium; sodium, magnesium, and calcium decrease progressively in the order given. Magnesium, however, distinctly depresses the uptake of potassium. Peech and Bradfield pointed out that calcium does not affect appreciably the uptake of potassium by plants, whereas potassium suppresses the uptake of both calcium and magnesium.

According to Pierre and Bower (1943), sodium has a tendency not only to increase potassium concentration of the soil solution but also to enhance the availability of soil potassium to plants.

Albrecht (1943) observed that although the amount of exchangeable calcium in the soil colloid may be ten times as great as that of exchangeable potassium, the latter makes up an average of 1.68 per cent of the plants, whereas calcium makes up 0.62 per cent.

Stewart and Volk (1946) found that an average of two-thirds potassium absorbed by experimental plants came from forms that were nonexchangeable at the beginning. They found no close relationship between the potassium removed by the crops and the exchangeable potassium in the soil, or remaining in the soil after cropping.

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[1] Central Experiment Station Contribution No. 1638. Based on the thesis presented for graduation by the senior author with the degree of Bachelor of Science in Agriculture from the College of Agriculture, April, 1951. Prepared in the Department of Soils under the direction of the junior author.

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Mehlick and Reed (1948) observed that by increasing the concentration of magnesium or potassium in the soil at all cation-exchange levels, the amounts of these cations extracted by HCl and those taken up by plants also increased. At the same time, the calcium decreased as a result of potassium levels. At constant magnesium or potassium level in the soil, the magnesium and potassium contents of the plants and in the HCl extracts increased with decreasing cation-exchange capacity. Increasing the calcium-magnesium and calcium-potassium ratios in the soil increased these ratios in plants and in the HCl extracts. The authors also reported that the addition of NaNO=$NaNO_3$ had the effect of replacing exchangeable potassium relatively more than replacing calcium.

In an experiment on the cation equilibria in plants and in soils, Van Itallie (1948) noted that plants grown in the cation-substituted soil were more susceptible to environmental conditions than those grown in the original untreated soil, as shown by the growth and yield of plants. He also advanced the idea that acid removes almost all bases in the exchangeable form and a small part of the calcium and magnesium present in other forms. He made a general survey of the uptake of the four cations and concluded that calcium uptake is wholly dependent on the ratio of calcium to the other three cations in the soil and not on the absolute quantity added. He further observed that the ratio of magnesium to the alkali ions in the soil chiefly determines the magnesium content of the plants, that the uptake of sodium depends chiefly on the uptake of potassium, and that the addition of magnesium and calcium has no appreciable influence on the sodium uptake.

Bear and Toth (1948) found that calcium is dominant in the soil, whereas potassium is dominant in alfalfa plants. These authors reported that plants tend to take up more potassium than they need, unless the calcium content of the soil is maintained at a relatively high level.

According to Breland, Bertramson, and Borland (1950), plants cause a large quantity of nonexchangeable potassium to be extracted from the soil. They failed, however, to establish any relationship between this amount and that initially present in the soil or that obtained after cropping. The ability of different soils to release potassium for plant consumption appears to be a dominant factor in the nutrition of plants and is a characteristic of each soil type.

MATERIALS AND METHODS

Los Baños clay loam, medium phase, taken from the U.P. Rural High School reservation which was covered with a moderate growth of *Calopogonium mucunoides* Desv., was used in this experiment. The surface soil is reddish-brown and about 15 centimeters deep. It pulverizes easily when dry and is sticky and plastic when wet. The physical and chemical analyses of the soil show that it contains 36.81 per cent clay, 25.73 per cent silt, and 37.46 per cent sand. Its

water-holding capacity is 69.45 per cent; loss on ignition, 12.16 per cent; and pH value, 6.96. It contains 0.69 per cent CaO, 12.16 per cent MgO, 0.31 per cent K_2O, and 0.09 per cent Na_2O.

The soil was air-dried, screened through a 1-cm. sieve, thoroughly mixed, placed in a funnel-shaped wooden tub, and carefully extracted with 0.1 N sulfuric acid solution until the titration value of the last portion of the extract no longer changed. The acid mechanically held by the soil particles was removed by washing with rain water. The soil was again dried in the air, passed through a 1-cm. sieve, and mixed well before being placed in one-gallon tin cans, 15 cm. in diameter and 18 cm. high, at the rate of 2.30 kilograms a can. The cans were perforated at the bottom and painted with coal tar to prevent rusting.

The experimental plan of the work, which consisted of six treatments of five replications each, is shown in table A. All the pots were allowed to age for two weeks before planting to thirty-day-old seedlings of nonheading lettuce at the rate of one to a pot. Forty days after planting, the plants were harvested and weighed.

The tops of the plants were dried to constant weight in the oven and then analyzed for their cations and phosphoric acid contents. In the evaluation of the data an analysis of variance for complete randomized design was used.

RESULTS AND DISCUSSION

The lettuce plants in treatments I, II, and III recovered their original vigor and appearance sooner than those in treatments IV, V, and VI. Except those in treatments I and IV, all the plants showed no difference in color and stand of growth during the first week. Marked differences in color and size, however, were noticed after the second week. On the whole, the replicate plants were more or less uniform in color and size. On the fourth week, the plants grown in the acid-extracted soil plus 2 S did not differ very much in size and color from those in the original soil plus 1 S. It was also observed that the leaves of the plants grown in the original soil plus 2 S were apparently larger, thicker, and darker than those in both acid-extracted soil plus 2 S and original soil plus 1 S. Figure 1 shows that the biggest and most vigorous plants were in treatments III, II, VI, and V. The plants in treatment I were bigger than those in treatment IV, which were the poorest.

Although the plants in the two plantings were not identical in size, in trend of growth and appearance they were parallel. The second planting was made three months after the harvest and after the soil in each pot, which had been placed under the shade to prevent unnecessary leaching, had been loosened and well-mixed. Figure 2 shows the appearance of lettuce plants in the second planting.

It is apparent in table 1 that the sum of the cations held in reserve after the extraction of the soil with 0.1 N H_2SO_4 was reduced from 41.57 to 27.78 milligram equivalents for every 100 grams of soil. The decrease, although not equally distributed, was shared

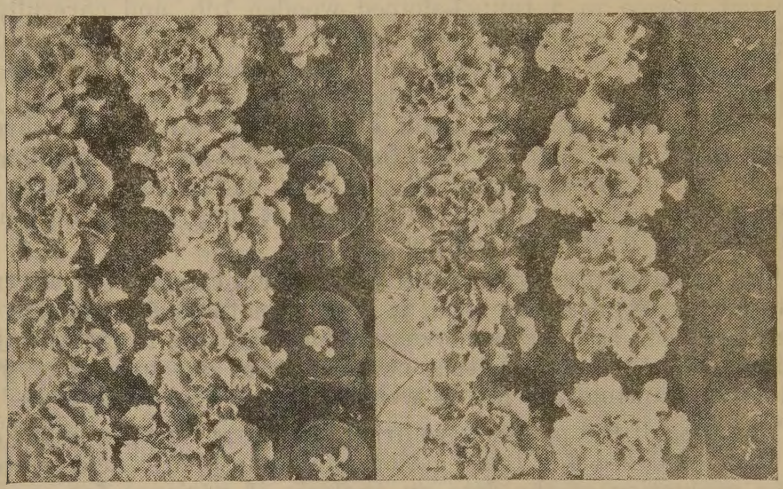

Fig. 1.—The lettuce plants in the first planting photographed to show, from left to right, the appearance of the plants in the original soil plus 2 S value of cations; in original soil plus 1 S value of cations; in soil alone; in acid-extracted soil plus 2 S value of cations; in acid-extracted soil plus 1 S value of cations; and in acid-extracted soil alone. (*Photographed by the Photographic Division, College of Agriculture*).

by each individual cation. The highest reduction was shown by calcium, followed in the order of magnitude by magnesium, potassium, and sodium. The amount of exchangeable bases showed a trend of results parallel to that of the cations held in reserve. Table 1 further shows that the extraction of the soil with 0.1 N acid almost completely exhausted the soil of its exchangeable bases and lowered the pH value from 6.96 to 5.63. The depletion was from 24.81 to 2.61 milligram equivalents for every 100 grams of soil.

The addition of 1 S and 2 S to the original soil changed the pH values from 6.96 to 7.40 and 7.43, respectively, whereas the same amounts of bases added to the acid-extracted soil changed the pH values from 5.63 to 6.50 and 7.13, respectively (table 2). The extraction of the soil with 0.1 N acid not only removed its exchangeable cations but also lowered its buffering property.

Table 3 gives the mean weights, the cations, and the phosphorus contents of the lettuce plants in the first planting. Based on the least significant mean difference of 9.72 grams, the difference in weight of the lettuce plants in treatments I and II was highly in favor of the latter, indicating that the yield of lettuce is markedly

increased by doubling the original cation content of the soil. However, the yield of treatment III, whose cation content was three times as much as treatment I, was only equal to that of treatment II, showing that the optimum amount of cation needed for a high yield

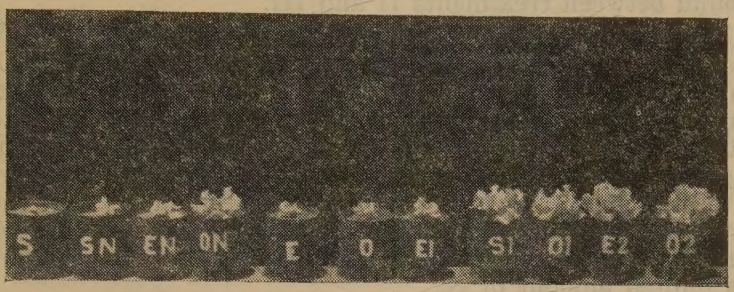

Fig. 2—The best plants in the different treatments in the second planting photographed to show the appearance of the lettuce plants in sand (S); sand plus $NaNO_3$ (SN); acid-extracted soil plus $NaNO_3$ (EN); original soil plus NO_3 (ON); acid-extracted soil alone (E); original soil alone (O); acid-extracted soil plus 1 S value of cations (E1); sand plus 1 S value of cations (S1); original soil plus 1 S value of cations (O1); acid-extracted soil plus 2 S value of cations (E2); and original soil plus 2 S value of cations (O2). S, SN, EN, ON, and S1 are of the first planting. (*Photographed by the Photographic Division, College of Agriculture*).

of lettuce is only twice as much as the cation content of the original soil. This result also revealed that the excess cations had no influence on the yield of lettuce.

The plants in treatment IV weighed less than those in treatment V or VI, showing that a soil exhausted of its exchangeable cations is unfit for planting.

Of the acid-treated soils, treatment VI, which received 2 S, gave the highest yield.

Although, theoretically, the amount of exchangeable bases of the acid-treated soil plus 1 S (V) was equal to that of the original soil (I), the former produced plants of heavier weight than the latter. This might be attributed to the fact that since the cations added were all water-soluble, they were naturally in a better position to adjust the soil conditions than the cations originally present in the soil. The yield of the acid-treated soil plus 2 S, which was supposed to have the same amount of exchangeable bases as the original soil plus 1 S, was not much more than that of the latter. This finding corroborates the previous conclusion that doubling the cation content of soil is essential to the attainment of the maximum yield.

Although the mean weights of the plants in the second planting (table 4) were lower than those of the first, the trend was similar in general. When the mean weight of treatment I was compared with those of treatments II and III, big differences in favor of treatments II and III were obtained. No significant difference, however, was found between treatments II and III.

Upon comparing treatment IV with treatments V and VI, the difference in mean weight between the plants in treatments IV and VI was found to be in favor of the latter. This shows that after the first planting, the cations remaining in the acid-extracted soil plus 1 S were just as ineffective as the acid-extracted soil in supporting the growth of lettuce plants. The difference in favor of VI when treatments IV, V, and VI were compared shows that the acid-extracted soil containing a large amount of S value of cations could support the growth of lettuce longer and better than the same soil with a limited amount of S.

Based on the computed mean difference of 1.52 grams, there was no difference between treatments I and V. Between treatments 11 and VI, however, a marked difference was found in favor of the latter.

It is also evident in table 4 that the reduction in yield was more pronounced in soils treated with bases. In the untreated soil the decrease was from 3.34 to 1.66 grams, whereas in the soils treated with varying amounts of bases, it was from 152.16, 150.76, 80.72, and 146.80 to 14.16, 15.28, 1.86, and 19.08, respectively. In the case of the untreated acid-extracted soil, the yield was increased from 0.28 to 1.02 grams.

Cation content of lettuce shoots

Calcium. The calcium content of the shoots increased as the amount of this ion in the original soil was increased (table 3). Based on the computed least significant mean difference of 2.35 m.e., the mean of treatment I was lower than that of either treatment II or III.

The trend of the amount of calcium in the plants grown in the acid-extracted soil was similar to that in the original soil in that the calcium increased as the amount of cations increased in the medium.

Of the treatments which theoretically had the same amount of cations, I and V gave a marked difference in favor of the latter, tending to show that the added calcium was more readily available than the calcium originally present in the soil. Between treatments II and VI, on the other hand, there was a large difference in favor of the former. This may mean that in the absorption of calcium, not only its solubility but also the nature of the medium is a contributory factor.

A similar trend of results was obtained in the second planting although, as expected, with the exception of treatment VI, it was

generally lower in calcium than the first planting. Between the treatments which contained equal amounts of calcium, no marked difference was found.

Magnesium. Unlike the calcium content, the magnesium content of the plants showed an indistinct trend of results. As shown in table 3, the differences between treatments I and II and treatments II and III were all in favor of treatment II. The trend of results shown by the plants in the acid-extracted series was quite similar to that of the original soil. The plants grown in the acid-extracted soil had a lower magnesium content than those in the acid-extracted soil plus bases.

However, when treatments which contained theoretically the same amount of magnesium were compared, results parallel to those concerning calcium were revealed. Although treatment III contained theoretically more magnesium ions than treatment VI, the amounts absorbed by the plants in the two treatments were similar.

The amount of magnesium in the second planting showed that the mean of treatment I was much lower than that of either treatment II or III (table 4). Unlike the first planting, no significant difference was obtained between treatments II and III. The trend of results in the acid-extracted series was similar to that in the original soils in that the last two treatments, which contained more cations, showed relatively higher concentrations of magnesium. The means of treatments I and V were the same, but those of II and VI differed in favor of the latter.

Potassium. The amount of potassium in the plants increased as the potassium in the medium increased (table 3). In the original soil, treatment I showed the least and treatment III, the highest. In the acid-extracted series, the lowest amount was found in treatment IV, and the highest, in treatment VI.

Only a slight difference was apparent between treatments I and V. Treatment II, however, showed a higher amount of potassium than treatment VI.

In the original soil series, the potassium content of the plants in the second planting was generally much lower than that in the first planting. This was not so in the acid-extracted series. Treatment V diminished, whereas treatment VI increased.

Between treatments I and V, a difference was obtained in favor of treatment V, whereas between treatments II and VI, the difference was in favor of the latter.

Sodium. The amount of sodium in the plant apparently increased as the exchangeable sodium was increased in the medium. Treatment I had a mean of 78.34 m.e., which was lower than those of treatments II and III whose difference was slight (table 3).

Among the acid-extracted soils, the lowest sodium content was found in the acid-extracted soil without any addition (IV). The

mean of the acid-extracted soil plus 2 S was higher than that of the acid-extracted soil plus 1 S.

The differences between the means of treatments I and V and between II and VI were all in favor of the acid-extracted soils given varying amounts of exchangeable bases. The data further show that the amount of sodium in treatment III, which was supposed to be one and a half times as much as that in treatment VI, was markedly lower.

Like the other cations which suffered a decrease as a result of partial exhaustion during the first planting, sodium in the original soil series decreased in the second planting. Table 3 shows that the mean of treatment I was lower than that of either treatment II or III.

A comparison of the results of treatments IV, V, and VI showed that treatment IV was much lower than either treatment V or VI in mean weight.

Between treatments I and V the difference was in favor of treatment V, whereas between treatments II and VI, no significant difference was obtained.

Phosphorus content of lettuce shoots

The phosphorus content of the plants varied from 8.17 m.e. in treatment IV to 50.63 in treatment III (table 3).

The mean values of treatments I, II, and III differed from each other (L.S.M.D.—2.38 m.e.), showing that the phosphorus contents of the plants were influenced by varying amounts of exchangeable bases in the medium. Incidentally, it may be recalled that potassium was added in the form of dipotassium phosphate, and this could be the alternative or the concomitant cause of the increased phosphorus in the plants.

Although the values were numerically lower, the same trend of results was evident in similar treatments of the acid-extracted soil. The lower values for this series may be attributed to the possibility that the physical and chemical reorganization of the soil resulting from the acid extraction and addition of the cations might have influenced the phosphorus uptake of the plants. The differences in the amount of phosphorus between treatments I and V and treatments II and VI were in favor of treatments I and II, the media of which were not extracted by acid.

The amount of phosphorus in the second planting was less than that in the first (table 4); nevertheless, the same trend of results was manifested.

Treatments II and III had more phosphorus than treatment I. The plants grown in the original soil plus 2 S (III) contained more phosphorus than those in the original soil plus 1 S (II).

Correspondingly, the acid-extracted soil without any addition had the least mean value for phosphorus; the acid-extracted soil

with I S had a higher value than that without, but lower than that to which 2 S was added.

Treatment I contained more phosphorus than treatment V. The difference between treatments II and VI was in favor of treatment II.

SUMMARY

1. The soil treated with 0.1N H_2SO_4 became less sticky and more friable, and its organic matter content became somewhat colloidal and clearly separated from the sand particles. Extraction of the soil with 0.1N H_2SO_4 not only reduced its pH value but also exhausted its exchangeable bases.

2. Lettuce plants transplanted to the original soils given different amounts of exchangeable bases recovered about one week earlier than those grown in the acid-extracted soils given corresponding amounts of exchangeable bases. The plants grown in the acid-extracted soils given varying amounts of bases were for some time smaller than those in the original soils. On the fourth week, however, the plants in treatment VI, which had been given the highest amount of cations, finally overtook those grown in the original soils.

3. Plants harvested from the original soils with different amounts of exchangeable bases showed higher yield than those harvested from original soil without additional cations. Likewise, the plants grown in the acid-extracted soils given different amounts of exchangeable bases yielded more than those in the acid-extracted soil alone. These results reveal that under the conditions of the experiment the added cations, namely Ca^{++}, Mg^{++}, K^{+}, and Na^{+}, are active growth-promoting factors.

4. The absorption of Ca^{++}, Mg^{++}, K^{+}, Na^{+}, and phosphorus by lettuce plants was enhanced, although not proportionately, by their amounts in the media. The addition of a bigger amount of exchangeable bases enhanced the absorption of K+ and Na+ but depressed that of Mg^{++}. Monovalent cations were more highly absorbed by the lettuce plant than bivalents.

5. The plants absorbed calcium least, despite the fact that it was present in large quantities in the soils. The biggest amount absorbed was potassium—followed by sodium and magnesium—showing that the need of lettuce plant for potassium is more than for the other cations. The range of phosphorus absorption was in the neighborhood of that of the bivalent cations, especially that of calcium.

6. Although the plants weighed less in the second planting than in the first planting, their weights increased as the amount of exchangeable cations was increased. The removal of the cations and phosphorus by the previous crop adversely affected the growth of the plants in the second planting and their absorption of exchangeable bases and phosphorus.

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TABLE A

Amount of cations added to the original and to the acid-extracted soil

TREATMENT	CALCIUM	MAGNESIUM	POTASSIUM	SODIUM
	m.e. %	*m.e. %*	*m.e. %*	*m.e. %*
I—Original soil		No cation added		
II—Original soil plus 1 S [a] ..	18.37	4.22	1.05	1.17
III—Original soil plus 2 S ...	36.74	8.44	2.10	2.34
IV—Acid-extracted soil		No cation added		
V—Acid-extracted soil plus 1 S	18.37	4.22	1.05	1.17
VI—Acid-extracted soil plus 2 S	36.74	8.44	2.10	2.34

[a] S is equal to the sum of 18.37 m.e. of calcium, 4.22 m.e. of magnesium, 1.05 m.e. of potassium, and 1.17 m.e. of sodium which were extracted by 0.1 N hydrochloric acid from one hundred grams of soil. Calcium was added in a solid form as calcium oxide. The other three cations were added in solution form as magnesium sulfate, dipotassium phosphate, and sodium nitrate.

TABLE 1

Cation contents of the original and acid-extracted soils

CATION	SOLUBLE IN 10 PER CENT HCl		SOLUBLE IN 0.1 N HCl	
	Original soil	Extracted soil	Original soil	Extracted soil
	m.e. %	*m.e. %*	*m.e. %*	*m.e. %*
Calcium	24.25	16.60	18.37	0.82
Magnesium	7.45	5.80	4.22	1.15
Potassium	6.73	5.01	1.05	0.38
Sodium	3.14	0.37	1.17	0.26
Sum of four bases	41.57 [a]	27.78	24.81 [b]	2.61

[a] Total, by calculation.

[b] Exchangeable, as determined by titration.

TABLE 2

Acidity of the media after addition of varying amounts of cations

TREATMENT	pH VALUE		REPLACEABLE HYDROGEN (grams per liter)
	H_2O	KCl	
I—Original soil (Control)	6.96	5.43	3.705×10^{-6}
II—Original soil plus 1 S	7.40	6.77	0.1317×10^{-6}
III—Original soil plus 2 S	7.43	6.83	0.0977×10^{-6}
IV—Acid-extracted soil	5.63	4.06	4.756×10^{-6}
V—Acid-extracted soil plus 1 S	6.50	4.96	0.780×10^{-6}
VI—Acid-extracted soil plus 2 S	7.13	6.40	0.324×10^{-6}

TABLE 3

Mean weights, amounts of calcium, magnesium, potassium, and sodium, and phosphorus contents of lettuce plants

(FIRST PLANTING)

TREATMENT	MEAN WEIGHT	Ca	Mg	K	Na	P
	grams	*m.e.*[a]	*m.e.*	*m.e.*	*m.e.*	*m.e.*
I—Original soil (Control)	3.34	12.22	35.23	138.11	78.34	22.52
II—Original soil plus 1 S	152.16	33.14	69.78	236.90	148.91	34.10
III—Original soil plus 2 S	150.76	50.34	51.84	267.59	155.69	50.63
IV—Acid-extracted soil ..	0.28	5.57	10.23	58.53	40.51	8.17
V—Acid-extracted soil plus 1 S	80.72	21.13	72.46	147.79	144.55	15.15
VI—Acid-extracted soil plus 2 S	146.80	25.30	54.09	165.61	175.09	24.59
L. S. M. D.	9.72	2.35	4.80	12.85	12.95	2.38

[a] Milliequivalent for every 100 grams of dry matter.

TABLE 4

Mean weights, amounts of calcium, magnesium, potassium and sodium, and phosphorus contents of lettuce plants

(SECOND PLANTING)

TREATMENT	MEAN WEIGHT	Ca	Mg	K	Na	P
	grams	*m.e.*[a]	*m.e.*	*m.e.*	*m.e.*	*m.e.*
I—Original soil (Control)	1.66	12.77	31.33	67.28	77.31	17.42
II—Original soil plus 1 S	14.16	31.99	44.53	185.27	144.62	25.88
III—Original soil plus 2 S	15.28	41.23	43.27	151.59	135.11	35.66
IV—Acid-extracted soil ..	1.02	3.68	3.84	31.98	24.75	7.27
V—Acid-extracted soil plus 1 S	1.86	12.93	30.09	144.13	152.24	13.78
VI—Acid-extracted soil plus 2 S	19.08	34.85	30.22	170.12	143.98	20.35
L. S. M. D.	1.52	4.14	3.25	10.76	12.92	1.95

[a] Milliequivalent for every 100 grams of dry matter.

INTER-GENERIC GRAFT AFFINITY OF THE CHICO[1]

LEON G. GONZALEZ AND EMIGDIO L. FABELLA

A more rapid method of producing large numbers of uniform planting materials of known performance is necessary to facilitate the establishment of commercial chico (*Achras zapota* Linn.) orchards. Hence, the present work was undertaken to study the inter-generic graft affinity of chico plants with certain species of the family Sapotaceae and to observe the grafts that united. The study was made from November, 1949, to February, 1952, in the Nursery of the Department of Agronomy.

MATERIALS AND METHODS

In this study, branches from bearing native and Ponderosa chico trees and native chico seedlings were used as scions, and as stocks, two- to three-year-old chico seedlings and seedlings of various ages and sizes of the following near-relatives of the chico: (1) *Calocarpum sapota* (Jacq.) Merr., (2) *Chrysophyllum cainito* Linn., (3) *C. oliviforme* Lam., (4) *Lucuma nervosa* A.-D.C., (5) Madhuca betis (Blanco) Merr., (6) *Palaquium foxworthii* Merr., (7) *P. merrillii* Dubard, (8) *P. philippense* (Pers.) C. B. Rob., and (9) *Sideroxylon duclitan* Blanco.

The chicos were grown from seeds of fruits produced in the College and its vicinity. The seedlings were potted and were used in the experiment when they were 29 months old.

Of the near-relative seedlings, some were collected about a year ago, and the majority were gathered from various parts of the College of Agriculture and the College of Forestry.[2] The plants were carefully dug up, transferred to suitable containers, placed under partial shade in the Nursery, and used in the experiment when they had recovered from the effects of balling and transplanting. Attempts were made to gather seeds of as many near-relatives as possible.

Also used in the study were plant containers, wrapping and tying materials, miscellaneous tools for measuring, and an improvised adobe-glass frame in which the newly cut grafts were kept to maintain them in a high degree of atmospheric humidity.

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[1] Central Experiment Station Contribution No. 1639. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Prepared in the Department of Agronomy under the direction of the senior author.

[2] Special thanks are due to Professor Calixto Mabesa of the College of Forestry for aid extended in gathering most of the near-relatives of chico and in identifying them.

Germination tests. The seeds of chico and some of its close relatives were washed and sown separately as soon as they were gathered (tables 1a and 1b). Records of their germination were kept. The height and girth of the seedlings were taken at the end of the observation period in order to compare the rate of growth of the chico and of the near-relatives.

Asexual method of plant propagation used. Inarching was preferred to other asexual methods of propagation because it affords the longest time possible for union of the stocks and scions. Inarching was done when the seedlings were sufficiently established. Gosaline drums containing the stocks were distributed at convenient levels close to the selected branches of the tree which had been carefully matched as to size. Incisions on one side of the scion and of the stock were made, about one-half of the thickness of each stem, from four to eight centimeters long, being removed. The two incised portions were brought together, care being taken to fit the two cambial regions, and carefully tied with a piece of waxed string. Changes of tying materials were made from time to time whenever necessary. To minimize distortion of the resulting grafts, care was taken to set the plant containers properly and firmly around the tree so that the scion was least bent. Plant were labeled, watered daily, and cared for.

In cases where small potted chico seedlings were used as scions, the containers of the inarched seedlings placed inside the glass-adobe chamber were fastened together as an added means of security. With the scions and the stocks supported by their own root systems, it was possible to extend the period of observation very much longer than if another method of grafting had been used.

Severing and leaf pruning. The inarches were cut from the mother tree at different intervals. A few were severed when they appeared to have united; others were allowed to remain on the plant for as long as six months. They were not left longer than six months because of the danger of scion distortion. To determine the optimum length of time for the union of the scion to the stock, a representative of each kind was cut from the stock at monthly intervals after the first severing. The wounds of the parts of the plant that were separated were painted to prevent the loss of an excessive amount of sap and to avoid fungus or bacterial infection. After severing the grafts, their leaves were pruned to half their size to reduce transpiration. To insure a more favorable condition for development, the severed inarches were placed in the special growing chamber constructed out of adobe stones and glass and in which air humidity was kept at a high level. These inarches were watered regularly. To protect them from intense heat of the sun, gunny sacks were spread over the glass covering of the chamber.

RESULTS AND DISCUSSION

Germination tests. The chico seeds from fresh and sound fruits gave germination rates considerably higher than those from decayed fruits or those seeds sown a few days after they were gathered. The fresh seeds gave percentages of germination ranging from 62.5 to 80.0, whereas the lots not immediately planted gave only from 40.0 to 60.0 (table 1a). The average percentage of germination of all the lots was 57.69.

As with the chico seeds, the source and promptness of planting influenced the viability of the seeds of the other sapotaceous plants (table 1b). Seeds of star-apple (*Chrysophyllum cainito*) planted soon after cleaning gave 62.50 to 75.00 per cent germination, or an average of 68.18 per cent. The seeds took 24 to 27 days to germinate.

Seeds from fresh, sound tiesa fruits (*Lucuma nervosa*) sown immediately after cleaning gave 70.00 to 90.00 per cent germination, or an average of 77.50 per cent. The seeds took 42 to 45 days to germinate.

With the seeds of caimitillo (*Chrysophyllum oliviforme*), germination ranged from 60.00 to 76.00 per cent, or an average of 68.00 per cent. The seeds took 34 to 36 days to germinate.

Rate of growth of the seedlings. The rate of growth of the chico was markedly slower. After 453 days, the seedlings had an average height of 12.06 centimeters and an average girth of 3.06 millimeters, measured one inch from the ground level. The star-apple seedlings after 341 days had an average height of 60.00 centimeters and a girth of 5.83 millimeters. The caimitillo seedlings after 416 days were, on the average, 13.02 centimeters in height and 4.45 millimeters in girth.

Inter-generic graft affinity of the chico. Among the different near-relatives tested as stocks for chico, only the 2½-year-old seedlings of the *Madhuca betis, Palaquium foxworthyi, P. merrillii,* and *P. philippense* showed signs of compatibility. The results obtained in this study are similar to those reported by Gonzalez and Salvador [3] for meliaceous fruit plants, by Gonzalez and Anoos [4] for guttiferous fruits, and by Gonzalez [5] for a number of other fruit plant families. In each of these studies, there was shown a selective range of compatibility within the plant family.

The other kinds of stocks failed to make a union with the scion in spite of extraordinary care, such as cutting them in several stages

[3] GONZALEZ, L. G., AND F. C. SALVADOR. 1950. Inter-generic graft affinity of lanzones, *Lansium domesticum* Correa. Philippine Agriculturist **34**: 21–25.

[4] GONZALEZ, L. G., AND QUIRINO A. ANOOS. The growth behavior of mangosteen and its near-relatives. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, 1951. Unpublished.)

[5] GONZALEZ, L. G. 1934. Outstanding results of agronomic and horticultural research. Philippine Agriculturist **23**: 380–397.

and placing them in a chamber to minimize transpiration. Soon after severance they dried out.

The experiment showed that the young seedlings united much faster than the older seedlings used as stocks. The older branches of chico showed signs of callusing much later than the 2½-year-old seedlings. With older branches, union was not effected until after six months. On the other hand, the young seedlings were well callused after one to two months and were well united three to four months after the operation. Theoretically, these observations are to be expected because in young seedlings the older cells of the xylem and the phloem have not yet gone too far towards the mature stage so that they can more easily "de-differentiate" to form profuse calluses. This can not be said of the older seedlings.

Pests and diseases. Except for the giant snail which attacked the leaves of many of the stocks, hardly any enemy was noticed. By putting baits composed of 5 per cent metaldehyde and 95 per cent fillers (sawdust) in strategic places, damage by the snails was reduced to insignificance.

SUMMARY

1. In the multiplication of chico by graftage, securing chico seedlings for stocks is a difficult problem. To help solve this problem, a search was made for more rapid-growing seedlings from the near-relatives, and their graft-affinity with the chico was determined.

2. The results of germination tests of the chico and some of its near-relatives indicate that the percentage of germination is high when fresh seeds are used. The limiting factor in stock production is not germination but the rate of growth of the seedlings and the time it takes them to grow to the size which can be used for inarching.

3. In the rate of growth of the three kinds of seedlings, the chico was the slowest. After 453 days, it had only an average height of 12.05 centimeters. The star-apple had 60.06, the tiesa or canistel, 55.68, and the caimitillo, 13.02 centimeters.

4. Of the nine near-relatives tested as stocks for the chico, four indicated high degrees of compatibility. These were *Palaquium forworthyi, P. merrillii, P. philippense,* and *Madhuca betis.* A further study of other stocks in larger quantities is recommended.

TABLE 1a

Germination of chico seeds

TEST NUMBER	SOURCE OF SEEDS	CONDITION OF SEEDS WHEN RECEIVED	PROMPTNESS OF SOWING	NUMBER OF SEEDS SOWN	DATE OF SOWING	DATE OF GERMINATION	NUMBER GERMINATED	PERCENTAGE OF GERMINATION
1	Collected from students	4 days old	3 days after collecting	30	Nov. 24, 1950	Jan. 1, 1951	14	46.66
2	"	"	"	30	"	Jan. 1, 1951	14	46.66
3	Collected from students	"	"	30	"	"	16	53.33
4	"	Very fresh	Soon after collecting	30	"	Jan. 2, 1951	20	66.66
5	Los Baños, Laguna	Very fresh	Soon after collecting	16	"	Jan. 3, 1951	11	68.75
6	Collected from students	"	2 days after collecting	16	"	Jan. 3, 1951	3	30.00
7	"	"	"	16	"	Jan. 3, 1951	8	50.00
8	"	"	"	16	"	Dec. 31, 1950	8	50.00
9	Collected from students	"	Soon after collecting	16	"	Dec. 31, 1950	10	62.50
10	Collected from students	"	2 days after collecting	16	"	Jan. 1, 1951	9	56.25
11	Collected from students	3 days old	"	20	"	Jan. 3, 1951	8	40.00
12	Los Baños, Laguna	Very fresh	Soon after collecting	20	"	Dec. 31, 1950	15	75.00
13	Collected from students	"	"	20	"	"	13	65.00
14	C. A. Nursery	"	"	20	"	"	16	80.00
15	Nursery laborers	"	1 day after collecting	20	"		12	60.00
16	"	Fresh	"	20		Jan. 3, 1951 Jan. 2, 1951	12	60.00
17	Collected from students	"	3 days after collecting	30	"	Dec. 31, 1950	10	60.00
	Total			366			204	980.81
	Average							57.69

TABLE 1b

Germination of some sapotaceous seeds

SPECIES	TEST NO.	SOURCE OF SEEDS	CONDITION OF SEEDS WHEN RECEIVED	PROMPTNESS OF SOWING	NUMBER OF SEEDS SOWN	DATE OF SOWING	DATE OF GERMINATION	NUMBER GERMINATED	PERCENTAGE GERMINATION
Chrysophyllum	1	College	Collected from	Planted soon af-	56			40	71.42
	2				56		April 8	37	66.07
cainito	3				56	March 15,	to 11,	35	62.50
	4	Nursery	sound fruits	ter cleaning	56	1951	1951	42	75.00
Linn.	5				56			36	64.28
	6				56			39	69.82
Total					336			229	409.09
Average									68.18
	1		Collected from	Sown after	10		Dec. 22	7	70.00
Lucuma	2	College	sound and	cleaning	10	Nov. 10,	to 25,	9	90.00
nervosa	3	orchard	fresh fruits		10	1951	1951	7	70.00
A.–D.C.	4				10			8	80.00
Total					40			31	310.00
Average									77.50
Chrysophyllum	1		Collected from	Planted 3 days	25			18	72.00
oliviforme	2	U.P.R.H.S.	sound and	after collect-	25	April 20,	May 24	19	76.00
Lam.	3	orchard	fresh fruits	ing	25	1951	to 26,	15	60.00
	4				25		1951	16	64.00
Total					100			68	272.00
Average									68.00

BREEDING HABITS OF BERKJALA SWINE[1]

CASIMERO D. BASCOS

A knowledge of the breeding habits of Berkjala sows and boars is essential to the efficiency and economy of swine raising. Hence, this study was conducted in the Department of Animal Husbandry, College of Agriculture, from June, 1950, to June, 1951.

MATERIALS AND METHODS

Six weanling pigs, nineteen yearling sows, ten two-year-old sows, four mature sows, and four boars were used in this study.

Each sow and her litter were kept in a hog pen with an adjoining outdoor run. The hog pens were two meters wide and 2.5 meters long and had concrete floors and board walls. The hog runs were seven meters long and 2.5 meters wide. Rice straw was provided as bedding for the nursing sows.

Between feeding hours, the pregnant sows had access to pastures 75 meters long and 25 meters wide. The pastures were usually covered with mixed grasses except during the dry season.

A Fairbanks-Morse portable scale of 750-kg. capacity and a metric tape were used to weigh and measure the sows.

The rations used, all parts by weight, were as follows:[2]

CONSTITUENTS	No. 1	No. 2	No. 3	No. 4
Corn	10	15	20	25
Rice bran	60	60	60	60
Copra meal	20	18	16	13
Fish meal	10	7	4	2
Total	100	100	100	100

Feeding and management of gilts and sows. All the animals were on the concentrate-pasture system of management. Gilts and sows were given feed mixture No. 3 and No. 4. They were hand-fed in the hog house most of the time and pastured out between feedings. Farrowing and nursing sows were kept in separate pens.

Gilts in gestation were given feed mixture No. 2 in the first half of pregnancy and ration No. 1 in the second half. Two-year-old

[1] Central Experiment Station Contribution No. 1640. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Prepared in the Department of Animal Husbandry under the direction of Associate Professor Mariano Mondoñedo.

[2] MONDOÑEDO, M. 1949. Hog raising. College of Agriculture Cir. No. 32: 1–16 (Revised).

sows in their second gestation received ration No. 3 and then No. 2. Mature pregnant sows were given ration No. 4 and then No. 3.

During the nursing period, each sow with her litter was confined in the nursing pen. The sow was allowed in a designated hog run two or three times a day regularly for exercise, fresh air, sunshine, and for her necessities. The pigs had access to the hog run adjoining the nursing pen. In addition to ration No. 1, the sow and her pigs were given about one kg. green soilage for every 100 kg. live weight from the fourth week to the end of the nursing period.

The breeding boars were kept in separate pens to avoid their fighting with each other. They were kept on the concentrate-pasture system of management when not in active service. When in active service, they were closely confined and were given feed mixture No. 1, 2, 3, or 4 depending upon their ages, conditions, and breeding activities. One boar was used as a teaser. During adverse weather, the animals were kept in the hog house. Drinking water was always made available to them.

Weighing. Every sow was weighed weekly after mating, during gestation, and after farrowing. The pigs were also weighed.

Measurement. The body girth of each sow was measured from the first to the last week of the gestation period.

Signs, duration, and intervals of oestrus. The animals were observed daily from 6:00 to 7:00 o'clock in the morning and from 4:00 to 6:00 in the afternoon. One to two days before a sow was expected to come in heat, the boar and the sow were confined in a small enclosure for close observation. From the first sign of heat, when the sow permitted the boar to mount, to the end of heat, observation was made day and night. Oestrus was ended when the sow refused to receive the boar even after repeated attempts to mount her. To further check the presence of heat, another boar used as a teaser was brought to the sow. The two were put together for about 30 minutes and then separated after the boar had repeatedly attempted to serve the sow and had been rejected.

The frequency and duration of mating and intervals between matings were also observed. The duration of mating was taken as the time between the successful insertion of the copulatory organ and its withdrawal.

Females which manifested oestrus were assumed to have reached the age of puberty. The date of the first manifestation of oestrus and the herd number of the animal were recorded. These animals, however, were not bred because they had not sufficiently attained the growth and development necessary to insure successful raising of progeny.

To determine the recurrence of oestrus after farrowing, the dam was brought to the boar daily for a week after the first day of farrowing. The sow that came in heat was bred by the boar. The

date of oestrus and the herd number of the animal were recorded. Nine sows were used in this study of post-partum breeding.

The length of time between weaning and reappearance of oestrus in sows were observed and recorded. All the seven sows that came in heat were bred.

To determine the interval between two consecutive oestruses, a boar with a strong fabric strapped in front of its sheath to prevent mating was brought to the sow in oestrus. Mounting took place. The length of time between the acceptance of the boar in the previous oestrus and acceptance in the following oestrus was taken as the interval between consecutive oestruses.

Signs of pregnancy and approaching parturition. The behavior of the sows during pregnancy and immediately before, during, and immediately after farrowing was carefully observed.

DISCUSSION OF RESULTS

Signs of oestrus. The following signs of oestrus were observed: (1) enlargement of the external genitals as evidenced by sensitivity to touch; (2) restless pacing and attempts to get to the confined boar or boars; (3) mounting of other animals in the same herd; (4) capricious appetite; (5) frequent attempts to urinate with little or no discharge; (6) distinctive grunts emitted constantly as if calling for the mate. These signs, according to Rice (1942) and Southwell, Wheeler, and Duncan (1940), lead to the period of sexual excitement in females. In this study, some of the signs were more common than the others and were more marked in some of the sows.

Duration of oestrus. The duration of oestrus ranged from 74 to 80 hours, or an average of 76.8 hours. The average duration of oestrus reported by Hughes and Heitman (1949) was 72 hours, which is 4.8 hours shorter than the result obtained in this study.

Occurrence of first oestrus in sows. Gilt No. 1142 came in heat when four months and two days old, the earliest in this study. Gilt No. 927 came in heat when six months and six days old. The average age at which the six females came in heat was four months and 25 days. Craig (1946) stated that gilts may conceive when four months old. Mondoñedo (1936) found that a male Berkjala pig reaches the age of puberty, as evidenced by the discovery of perfectly formed living sperms in the testes, at 16 weeks of age.

Recurrence of oestrus after farrowing. Nine sows came in heat two to four days after farrowing, the average being three days. Each sow was bred to a boar; none, however, was safely settled. Mondoñedo (unpublished records) observed that sows come in heat soon after farrowing if they lose their pigs by accident or by design. If bred, they may safely settle. Coburn in 1906, as cited by Warnick, Casida, and Grummer (1950), observed that sows will take the boar from the second to the fourth day after farrowing. Smith cited a statement of Robinson in the Ohio Experimental Station

Bulletin No. 5, volume III, that sows may be safely settled while still nursing their litters provided that the sows are separated from their litters at night during the nursing period. In this study, the sows and their litters were not separated.

Seven of the sows did not come in heat during the eight-week nursing period. Sow No. 74 came in heat 16 days after weaning and sow No. 316, two days after weaning, the latest and the earliest, respectively. The average time for the seven sows to come in heat was 7.14 days after weaning.

Interval between consecutive oestruses. The interval between two consecutive oestruses in the individual sows ranged from 19 days in sow No. 601 and No. 104 to 22 days in sow No. 31. The average interval for the 12 sows was 20.13 days.

Behavior of sow and boar. The sow refused to be mounted except at the maximum height of heat, when she was quiet and passive. The copulatory act was then accomplished easily and quickly. The sows in heat approached the boar and allowed the boar to cover. Two sows smelled the reproductive organ of the boar, and three sows grunted during mating.

All the boars manifested the following behavior: (a) approaching of the sow, (b) smelling of the external genital organ of the sow, (c) pausing before protrusion, (d) protrusion of penis, (e) passing of droplets of watery discharge, and (f) mounting and mating.

When the height of heat had passed, the sow would no longer allow the boar to consummate the service. When oestrus had subsided, the sow and the boar paid no more attention to each other. Mating occurred more frequently early in the morning before feeding, late in the afternoon, after feeding, and about noontime. Mating rarely occurred at night when sow and boar were found at rest.

Frequency of mating in one oestrus. Sow No. 74 was bred by boar No. 275 seven times, and sow No. 234 by boar No. 275 six times. The average number of matings for the five sows was 6.6 times.

Interval between matings. In the case of sow No. 355, which accepted the boar seven times in one oestrual period, the average interval between matings was 10.58 hours, the shortest among the sows studied. In the case of sow No. 193, the average interval between six services was 12.68 hours, which was the longest. The average interval for the five sows was 11.70 hours.

Duration of mating. The average duration of mating of sow No. 391 was 3.25 minutes, the shortest among the sows observed; that of sow No. 74 was 4.16 minutes, the longest. The average was 3.59 minutes.

Signs of pregnancy. The following signs of pregnancy were observed: (a) cessation of the recurrence of oestrus; (b) change in disposition— the sows became more quiet, showed more appetite,

and grazed more closely; (c) rapid gain in weight and rapid increase in measurement of middle girth, and (d) movement of the fetuses in the uterus.

The increase in weight ranged from 13.00 kg., or 10.03 per cent of the initial weight in the case of sow No. 269, to 72.40 kg., or 51.20 per cent increase in the case of sow No. 193. The greatest percentage of increase over the initial weight, however, was 68.89 per cent, which was made by sow No. 271. The average gain in weight of the 13 sows was 36.74 kg., or 34.02 per cent of the initial weight.

The middle girths of the sows increased rapidly and steadily. The average increase made by 13 sows for the entire period of gestation was 32.02 cm., or 23.85 per cent of the measurement taken after the animals were bred.

Gestation. The length of the gestation period ranged from 111 to 116 days. The average for the 15 sows studied was 113.66 days. The average gestation period reported by Hughes and Heitman (1949) and Rice (1942) is slightly longer than the result obtained in this study.

Signs of approaching parturition. The following signs of approaching farrowing were observed: (1) a more or less sudden development of the motherly instinct five to ten days before farrowing, as shown by the sow's desire to protect her young; (2) gathering of materials for bedding for the coming litter one to two days before farrowing; (3) marked enlargement of the mammary glands and of the external genitals one to two days before farrowing; (4) sudden dropping of the abdomen, hollowing of the flanks, and sinking of the rumps one to three days before farrowing.

Farrowing. Parturition began with the rupture of the fetal membrane. The interval between the rupture of the fetal membrane and the expulsion of the first fetus ranged from 0.20 hour, or 12 minutes, in sow No. 148 to 0.32 hour, or 19.20 minutes, in sow No. 271. The average for the sows observed was 0.242 hour, or 14.52 minutes. During these intervals, the sows periodically extended their upper hind legs forward and then kicked them backward. At each motion, fluid trickled out through the aperture; between motions, little or no fluid came out.

The average interval of expulsion of the fetuses ranged from 0.136 hour, or 8.16 minutes, in sow No. 148 to 0.319 hour, or 19.14 minutes, in sow No. 120. The general average for the six sows studied was 0.224 hour, or 13.44 minutes. The longest interval of expulsion of pigs reported by Rice (1942) was one hour. In this study, the longest interval was one hour and 31 minutes in sow No. 120; the shortest was one minute in sow No. 137.

The time between the expulsion of the last fetus and the initial expulsion of the placenta ranged from 0.13 hour, or 7.8 minutes, in sow No. 271 to 1.40 hours, or 84 minutes, in sow No. 137. The

time between the expulsion of the last fetus and the complete dropping of the placenta in sow No. 271 was 0.39 hour, or 23.4 minutes, and that in sow No. 137 was 8.15 hours. The average for the six sows was 3.70 hours.

The length of time of farrowing ranged from 2.88 hours for sow No. 271 to 10.98 hours for sow No. 137. The average for all the sows was 5.97 hours, or five hours and 58 minutes.

The loss in weight of the sows incident to parturition ranged from 7.00 kg., or 4.85 per cent, for sow No. 269 to 16.50 kg., or 8.75 per cent, for sow No. 136. The average for the 12 sows was 12.43 kg., or 8.09 per cent of the weight before farrowing. The weight lost was the weight of the fetal membrane, placenta, and amniotic fluid. The initial weight of each litter ranged from 5.50 to 11.40 kg., or an average of 8.53 kg.

Every pig at expulsion was covered with a transparent membrane. The stronger ones were freed from this covering by their repeated struggles to get up during the rapid drying up of the membrane. After a few minutes, the young instinctively looked for the mammary glands.

All the sows, except sow No. 120, ate the placenta.

SUMMARY

1. The most common signs of oestrus noted in this study were restlessness, loss of appetite, mounting of other hogs regardless of sex, congestion of the vulva, frequent attempts to urinate with little or no discharge, distinctive grunts emitted constantly as if calling for the mate.

2. Oestrus occured for the first time in pigs when four months and two days to six months and six days old. The average age was four months and 25 days. The length of the oestrual period ranged from 74 to 80 hours. The average period was 76.80 hours. Oestrus recurred two to four days after farrowing, or an average of three days. Nine of the 16 sows came in heat two to four days after farrowing; although they were successfully bred, none became pregnant. All the seven sows bred after weaning were safely settled.

3. The interval between weaning and reappearance of oestrus ranged from two to 16 days. The average interval was 7.14 days. The interval between oestruses in unbred sows ranged from 19 to 22 days, the average being 20.13 days.

4. The number of services that the sow allowed the boar in one heat ranged from six to seven. The average number allowed by the five sows was 6.6. The duration of mating ranged from 3.25 to 4.16 minutes, or an average of 3.59 minutes. The average interval between consecutive matings ranged from 10.58 to 12.68 hours. The average interval was 11.70 hours for the five sows.

5. The interval of expulsion of the fetuses of the six sows ranged from one minute to one hour and 31 minutes. The average interval ranged from 0.136 hour, or 8.16 minutes, to 0.319 hour, or 19.14 minutes. The general average was 0.224 hour, or 13.44 minutes. The time between the expulsion of the last fetus and that of the placenta ranged from 0.39 hour, or 23.4 minutes, to 8.15 hours, or an average of 3.70 hours. The duration of parturition ranged from 2.88 to 10.98 hours. The average period was 5.97 hours.

6. The gestation period ranged from 111 to 116 days, or an average of 113.66 days.

7. The loss in weight of the farrowing sows ranged from 7.00 to 16.50 kg. The average loss was 12.43 kg.

8. The average weight of the litters at birth was 8.53 kg., and the average weight of the placenta and fluid was 3.90 kg.

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THE MARKETING OF MANDARINS, CITRUS NOBILIS LOUR., PRODUCED IN 1951 IN THE PROVINCE OF BATANGAS [1]

N. B. Tablante and Dominador M. Tombo, Jr.

With the strict enforcement of import control measures, the importation of citrus fruits would be greatly curtailed, and the domestic market for this product would be expanded considerably to the ultimate advantage of the Batangas citrus growers. Under these circumstances, a knowledge of the economic aspects of marketing this agricultural product would be valuable in discovering the defects of the marketing system and in forming a basis for improving this rapidly growing industry.

Bagui [2] reported that citrus on the trees may be sold for a lump sum to an itinerant speculator who attends to the picking or may be contracted to large hotels or large market dealers.

Balmaceda [3] stated that the methods of marketing employed by the average farmer are haphazard and totally individualistic in nature and that the present low economic position of the small producers could be attributed, in part, to their inability to market their products effectively. Tablante [4] remarked that marketing problems are not similar for all farmers and much less for all kinds of products. Farmers should, therefore, plan their marketing operations according to the individual needs of their respective farms.

De Leon [5] suggested that because of the small production and small per capita consumption of mandarins in this country, there is a need for increased development of the citrus industry to promote a more widespread consumption of citrus fruits in the Philippines. He mentioned the great possibility of expanding the market for the most important commercial varieties of locally grown citrus, the mandarins and the pummelos, if the government would follow its policy of encouraging and protecting the development of local farm indus-

[1] Central Experiment Station Contribution No. 1641. Based on a thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Prepared in the Department of Agricultural Economics under the direction of the senior author.

[2] Bagui, C. G. 1924. Commercial citrus production in Batangas Province and means of improvement. Philippine Agriculturist 12: 29–42.

[3] Balmaceda, Cornelio. 1950. How to market your farm products. Agricultural and Industrial Life 12 (4): 6–7, 29.

[4] Tablante, N. B. 1951. Planning for efficient marketing. Agricultural and Industrial Life 13 (9): 12 & 41.

[5] De Leon, Jose. 1951. Citrus growing in the Philippines. Department of Agriculture and Natural Resources Popular Bulletin No. 40: 1–62.

tries. Torres and Aala [6] stated that in this country the methods of preparing citrus fruits for the market are simple and crude. They recommended the improvement of the method of handling and the use of standard-sized crates in order to build up our citrus trade.

A study was conducted in the principal citrus-producing towns of Batangas, namely, Tanauan, Santo Tomas, Batangas, Rosario, San Juan, Lemery, Cuenca, Taal, Talisay, and Lipa City, from January, 1951, to January, 1952. The aims of the work were to study the methods and practices involved in the marketing of mandarins and to understand the problems encountered in the marketing system.

METHOD OF STUDY

A list of citrus growers was secured from the municipal treasurer of each of the citrus-producing towns surveyed, to obtain the population which is defined as growers having at least a hundred bearing trees each. The survey method of investigation was used in gathering the necessary data. Growers comprising the population were interviewed for information on the marketing of the 1951 mandarin crop. Buyers, contractors, transportation agencies, and retailers were also interviewed to supplement the data supplied by the citrus growers. Much of the survey work was done from September, 1951, to January, 1952.

DISCUSSION OF FINDINGS

Area and production. A total of 103 citrus farms in Lipa City and in nine towns in Batangas were surveyed (table 1). These farms had an aggregate area of 295 hectares, averaging 2.86 hectares to a farm, and a total of 58,988 bearing trees, an average of 573 bearing trees to a farm, or 200 fruit trees to a hectare. Seventeen of these farms each had an area of 0.5 hectare. Twenty-nine had one hectare; twenty had 1.5; sixteen, 2; three, 2.5; four, 4; two, 5; one, 5.5; two, 6; two, 10; and one each, 7, 7.5, 8, 8.5, 105, 12, and 60 hectares, respectively.

The varieties of mandarins produced on these farms were the Ladu, King, Batangas, and Szinkom. In this connection, a short description of each variety, as taken from De Leon [7], is here given, not for the purpose of going into the botanical details of these fruits, but for distinguishing the varieties treated in this study.

The Ladu mandarin was introduced from India about 1912. The fruit is oblate, medium-sized, of a bright orange color, and weighs an average of about 117 grams. The seeds are many, averaging 21 to a fruit. The fruit is always juicy even when thoroughly ripe. It is one of the late-maturing varieties, being in season from January to March. The tree reaches full bearing age in 10 to 12 years

[6] TORRES, J. P., AND F. T. AALA. 1948. The citrus industry in the Philippines: its culture and improvement. Plant Industry Digest 11 (1): 2–17.

[7] De Leon, *op. cit.*

and gives an average yield of 12,000 to 14,000 kilos of fruits a hectare. Its main defects are its irregular bearing habit, seediness, and somewhat too acid flavor when not fully ripe.

King mandarin is sometimes called "The King of Siam." This variety was introduced from Florida, U. S. A. The fruit is large-sized, oblate, with a rough and thick rind, and weighs an average of about 180 grams but sometimes as much as 400 grams. It has about 20 large seeds. The flesh is dark orange, very juicy, and of excellent flavor. The King tree is fairly prolitic and early-bearing, producing from 8,000 to 10,000 kilos of fruits to a hectare a year. The defects of this variety are brittleness of the wood, high susceptibility to citrus scab, and comparatively low fruit yield.

Batangas mandarin was, until recently, the only variety grown commercially in Batangas. Consumers have regarded this variety as an excellent mandarin; it is universally accepted as a fine fruit. However, it proved to be unprofitable when grown at the Lipa Citrus Experiment Station, principally because it is a comparatively delicate variety and requires very good soil for satisfactory bearing. It is quite prone to the attack of bark diseases and citrus scab, and it seldom yields heavily. It is easily damaged by strong winds and typhoons.

Szinkom mandarin was introduced from China and India in 1912. It has become one of the most popular comercial varieties because of its good growth and regular bearing habits. The fruit is small-sized, weighs an average of approximately 86 grams, is oblate, and is yellowish-orange when ripe. It has a characteristic aroma, with a flavor pleasantly sweet sub-acid. Each fruit has about 16 short and plump seeds and tends to dry up when overripe. The tree begins to bear three to four years after planting. A good and regular bearer, it averages at 10 years of age about 12,000 to 15,000 kilos of fruits to a hectare a year. It is an early maturing variety.

The 103 farms surveyed marketed, on the average, 1,408 "kaings" of mandarins to a farm, or 492 "kaings" to a hectare. The Szinkom variety had the largest quantity marketed in all the farms, averaging 428 "kaings" to a farm, or 149 "kaings" to a hectare. The Batangas variety had the lowest, averaging only 294 "kaings" to a farm, or 103 "kaings" to a hectare.

Variations in volume of marketing. Table 2 shows the monthly quantities marketed of the different varieties of mandarin. The marketing season was usually from October to January. Fruits harvested and marketed outside of this period comprised only an insignificant portion of the total volume of marketing and were, therefore, excluded from this report.

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[5] "Kaing" as used here is a basketful of fruits weighing an average of about 25 kilos.

For this period, of a total of 145,017 "kaings" of all varieties marketed from the 103 farms included in this study, 44,067 "kaings" were of Szinkom, 37,952 "kaings" were of King, 32,693 "kaings" were of Ladu, and 30,305 "kaings" were of Batangas. These quantities were 30 per cent, 26 per cent, 23 per cent, and 21 per cent, respectively, of the total quantity marketed for the entire season. November was the month of heaviest marketing for the Szinkom and Batangas varieties, and December for the King and Ladu, as well as for all varieties. Fifty-one farms reported marketing the Szinkom variety; 40, the King; and 29 each, the other two varieties. On the basis of average quantity marketed by each farm reporting the respective varieties, Ladu and Batangas mandarins ranked first in importance, and King, the least. However, as has been noted in table 1, considering the general average for all the farms surveyed, the ranking varieties in the order of importance according to total quantity marketed were Szinkom, King, Ladu, and Batangas.

The average selling price of these fruits varied monthly according to variety. The lowest-priced variety was Szinkom, the price ranging from ₱6.00 to ₱9.50 a "kaing" of fruits, or an average of ₱7.66 for the season; and the highest-priced was Ladu, the price ranging from ₱13.50 to ₱19.50 a basketful, or an average of ₱16.50 a "kaing" for the season (table 2). Generally, the price was lowest when the volume of marketing was highest, and vice versa.

Method of sale. Citrus growers included in this study sold their products on a contract basis similar to that reported by Bagui [9] in 1924. Contracts were either written or verbal, but more commonly written, especially when the contractor was not well-known to the grower. The contractors went to the farms either when the fruit trees were in an advanced stage of flowering or when the fruits had started to set. These buyers then made their estimates of the prices they would be willing to pay.

It is interesting to note how the buyers estimate the contract price by merely observing the stand of the crops in the field and the degree of fruiting. When growers and contractors have agreed on the price, the transaction is closed, and the right to harvest the fruits is transferred from owner to buyer, with the contract buyer attending to all the harvesting operations and assuming all expenses from then on. An accurate and safe estimate determines the profitableness of the business of contracting. If the contractor overestimates the production of the farm, he will pay a high price but get low returns. Selling the crop on contract basis may be considered a gamble on the part of the buyer and a safe investment on the part of the producers when one takes into account that the yield may be affected by various factors beyond the control of man after the contract has been made.

[9] Bagui, *op. cit.*

While the contract system was the method generally used in selling the fruits, variations existed regarding the conditions of payment. Some growers were given an advance payment equal to 60 per cent of the total contract price at the time the contract was consummated, that is, before the harvest; then 20 per cent was paid after the first harvest, and the rest, by installment. Thirteen farms followed this method. Forty farms were paid 50 per cent down payment at the time of the contract, and the remaining half of the total price was given after the crop had been harvested. The rest of the farms surveyed followed a system by which the amount of advance payment and other conditions were determined by mutual agreement entered into by both parties to the transaction.

The 103 farms were contracted for an aggregate amount of ₱921,380, at an average of ₱8,945 a farm, or ₱3,113 a hectare. The individual prices ranged from ₱1,200 for a one-hectare farm having 200 bearing trees and producing 650 "kaings" of King mandarin to ₱75,000 for a 60-hectare farm having 6,000 bearing trees, or a total harvest of 17,500 "kaings" consisting of 3,700 "kaings" of Ladu, 4,000 of King, 1,800 of Batangas, and 8,000 of Szinkom. There were only four farms, with an average of 0.6 hectare, 148 bearing trees, and 740 "kaings" of fruits marketed, that were contracted for less than ₱2,000 (table 3). Nineteen farms, on the other hand, were contracted at a price exceeding ₱10,000, or an average of ₱26,691 a farm. These farms had an average of 8.5 hectares, 1,773 bearing trees, and 8,212 "kaings" of all varieties of mandarin marketed. It may be noted that, with slight variations, the contract price tends to increase in direct proportion to the area, number of bearing trees, and fruit yield.

Market channels and retail outlets. Citrus growers disposed of their crop by having it contracted by buyers coming to the farms. These contract buyers then sold the crop to other buyers, warehouses, and retailers. Warehousemen bought from and/or sold to other buyers. Retailers in public markets, retail stores, and peddlers obtained their stock of mandarins from buyers or from warehouses. Finally the product reached the consumers through the retailers. The fruits were transported by trucks to the neighboring towns, to the cities of Cavite, Manila, and Pasay, and to some towns in Cavite, Rizal, and Laguna.

Market financing. The major portion of financing was shouldered by middlemen. Contractors made down payments either with their own cash or with loans from warehouses to whom they had previously arranged to sell the fruits they were purchasing. In some instances, contract buyers secured loans from private individuals or from banks in order not to bind themselves to sell to particular warehouses. When a contractor was given a loan by a warehouseman, the former was under obligation to deliver a stipulated number of "kaings" to the warehouse within a specified period.

Marketing cost. Table 4 shows the costs involved in marketing a "kaing" of mandarin fruits. According to Weld,[10] "the difference between the price received by the farmer for any commodity and the price paid by the final consumer measures roughly the costs and profits of marketing that commodity." The difference between the amount received by the farmer expressed as a percentage of the final consumer price and 100 per cent represents, therefore, the proportion of final price consumed by marketing costs.

Considering the general average for all varieties marketed, the producer received only ₱6.35, which was about 49 per cent of the average retail price of ₱13.00 a "kaing." The difference between the average retail price and the average price received by the producer amounted to ₱6.65, or about 51 per cent of the consumer's price. The total marketing cost, up to and including warehousing, of ₱2.30 a "kaing" was almost 18 per cent of the price paid by the consumer. The margin covering the cost of retailing and the profits of the middlemen was almost one-third of the average retail price, or about ₱4.35 a "kaing."

After the contract has been made, it is necessary to post a guard in the orchard to prevent the fruits from being stolen. This guard is paid from ₱2.00 to ₱2.50 a day. On the average, the cost of guarding amounts to 13 centavos a "kaing" at harvest during the three-month period.

Fruit harvesters were paid from 25 to 60 centavos, or an average of 33 centavos, for a "kaing" of mandarins picked . Other items of cost included the cost of sorting and packing, hauling, transporting, and warehousing. Transportation costs varied according to the distance of the haul. Storage fees ranged from 80 centavos to one peso a "kaing." It is necessary to place the fruits in the warehouse so as to await better prices in the market. All of these costs of marketing were necessarily borne by the contractors since the responsibility of the growers ceased after the contract had been drawn up.

Marketing problems. From the standpoint of the citrus planters, the following marketing problems were noted:

a. Lack of adequate facilities to finance production and marketing operations.

b. Growing of varieties regardless of the consumers' preferences.

c. Insufficient attention to sorting and grading the products primarily because of the nonexistence of established standards and partially because of lack of incentive to produce higher grades.

d. Inadequate knowledge of market conditions and inadequate facilities for marketing, such as warehousing, curing, and refrigerating.

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[10] WELD, L. D. H. 1916. The marketing of farm products. xiv + 483 p. New York: The Macmillan Company.

e. Improper utilization or throwing away of wastes and by-products.

f. Unnecessary competition among growers in individual selling. The proposed solutions to these problems are given in detail in the recommendations made.

SUMMARY

1. The 103 growers found in Batangas, Rosario, Santo Tomas, Tanauan, San Juan, Taal, Cuenca, Lemery, Talisay, and Lipa City had an aggregate area of 295 hectares with a total of 58,988 bearing trees, or an average of 2.86 hectares with 573 bearing trees to a farm, or 200 fruit trees to a hectare. They marketed about 1,408 "kaings" of fruits to a farm, or 490 "kaings" to a hectare.

2. The varieties of mandarin produced were Ladu, King, Batangas, and Szinkom. For the marketing season from October to January, there was a total of 145, 017 "kaings" of fruits marketed. This total consisted of 44,067 "kaings" of Szinkom, 37,952 "kaings" of King, 32,693 "kaings" of Ladu, and 30,305 "kaings" of Batangas mandarin, which were about 30 per cent, 26 per cent, 23 per cent, and 21 per cent, respectively, of the total quantities marketed. Based on the average quantity marketed by each farm reporting each of the respective varieties, Ladu and Batangas were the most important, but on the basis of average marketing made by all the farms included in the survey, Szinkom ranked first and King second.

3. Mandarin fruits were sold by growers on a contract basis, that is, the production of the entire farm was contracted by a buyer on the basis of an estimate of production made prior to the harvest season. Contracts were mostly written; some were only verbal agreements between the two parties.

4. The terms of payment of the contract price generally varied, depending upon the agreement entered into by the grower and the contractor. Some contractors were asked to give 60 per cent of the total price as down payment, with the remainder settled in two or more installments. Others gave 50 per cent down payment, and the other half was paid in a lump sum or in installments after the harvest.

5. All the farms were contracted at an aggregate amount of ₱921,380, averaging ₱8,945 to a farm, or ₱3,113 to a hactare. Individual contract prices ranged from ₱1,200 for a one-hectare farm having 200 bearing trees which produced 650 "kaings" of King to ₱75,000 for a 60-hectare farm having 6,000 bearing trees which produced 3,700 "kaings" of Ladu, 4,000 of King, 1,800 of Batangas, and 8,000 of Szinkom. With slight variations, the contract price was directly proportional to the area, number of bearing trees, and fruit yield of the farm.

6. The important market channels of mandarin were from the growers to the contractors or wholesale buyers, to the warehouses, then to the retailers, and finally to the consumers. Fruits were mar-

keted by truck to different towns of the provinces of Batangas, Cavite, Rizal, and Laguna, but the cities of Pasay, Manila, and Cavite consumed the greater bulk of the marketed fruits.

7. Middlemen shouldered the major portion of market financing. Contractors, aside from their own capital, secured the funds that they paid to growers from banks or private individuals and, in many cases, from the warehouse owners, who were usually alien capitalists.

8. Average retail prices to a "kaing" were from ₱6.00 to ₱9.50 for Szinkom, ₱10.00 to ₱15.00 for Batangas, ₱13.00 to ₱18.00 for King, and ₱13.50 to ₱19.50 for Ladu. Szinkom was the lowest-priced variety, and Ladu, the highest. In general, the prices had a tendency to increase from the beginning to the end of the marketing season: that is, from October to January, the price increased from an average of ₱6.00 to ₱17.50 a "kaing" for all varieties.

9. Citrus growers received, on the average, ₱6.35 for a "kaing" of mandarins which was equal to about 49 per cent of the average consumer price, ₱13.00 a "kaing."

10. The difference between the average retail price and the average price received by the producer amounted to ₱6.65 a "kaing," or 51 per cent of the final retail price. This margin was made up of marketing costs up to and including warehousing, ₱2.30, and a margin covering the cost of retailing and the profits of middlemen, to ₱4.35 a "kaing," representing 18 per cent and 33 per cent, respectively, of the average retail price.

11. The different items of cost incurred in marketing a "kaing" of mandarins up to warehousing were guarding, ₱0.13; picking the fruits, ₱0.33; sorting and packing, ₱0.15; hauling, ₱0.12; transporting, ₱0.67; and warehousing, ₱0.90. The largest single item of marketing cost, except for the profits of middlemen, was warehousing or storing which was equal to 39 per cent of the total marketing cost, 13.54 per cent of the total margin, or about 7 per cent of the average retail price.

12. The marketing problems of the fruit growers included lack of adequate marketing and financing facilities, lack of incentive to improve the varieties grown and marketed, insufficient attention to sorting and grading of products, absence of established standards, inadequate market information, improper utilization of by-products and wastes, and unnecessary competition among producers.

RECOMMENDATIONS

The formation of a federated citrus growers' cooperative marketing association, working under a plan of organization and management similar to that of the California Fruit Growers Exchange

system (Fogelberg and McKay, 1940),[11] is highly recommended to the citrus planters in the province of Batangas. Most of the weaknesses in the production and the marketing of citrus fruits can be effectively remedied by such an organization. An efficient system of distribution will be developed, and the general welfare of the producers will be enhanced.

The association can furnish the necessary facilities and agencies through which the citrus fruits and by-products of the member-growers may be marketed to the maximum advantage of the members. It will tend to reduce the cost of marketing since the cooperative will act as the main agency of distribution, and whatever savings will be effected will be returned to the members in the form of patronage dividends. It will improve the methods of fruit handling, grading, and packing, as well as the quality of the product. It will give the members greater bargaining power in the market, and it will provide the means by which the financing of production and marketing operations can be very well carried out. Members will also be furnished with orchard and marketing supplies at net savings. They will be relieved of the trouble of marketing their products individually and often at the mercy of unscrupulous middlemen. The association can stimulate the demand for citrus fruits and thereby increase the consumption of these products through successful advertising campaigns and constant research to keep fruit quality at a maximum, to make use of products and by-products, and to bring about an equitable distribution at all times to all markets and to new markets that may be developed. In short, the association will safeguard the general interest of the citrus industry and will therefore give greater returns to the producers for their products.

It is further recommended that the government extend every possible help to the citrus growers by developing and distributing improved varieties at cost in experiment stations, controlling pests and diseases of citrus, conducting other valuable research, exploring the possibilities of expanding the market for citrus fruits not only at home but also to other countries, giving more accurate and reliable market information, giving financial assistance, and eliminating too much "red tape" in government agencies that directly or indirectly cater to the needs of the citrus industry.

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[11] Fogelberg, N., and A. W. McKay. 1940. The citrus industry and the California Fruit Growers Exchange system. Farm Credit Administration, U. S. Department of Agriculture Circular No. C–121.

TABLE 1

Distribution of farms surveyed according to location

LOCALITY	NO. OF FARMS	AREA	
		Total	Average to a farm
		hectares	*hectares*
Batangas	52	70.5	1.36
Lipa	31	126.5	4.08
Rosario	7	73.0	10.42
Santo Tomas	3	6.5	2.17
Tanauan	3	4.5	1.50
San Juan	2	6.0	1.50
Taal	2	2.0	2.00
Cuenca	1	2.0	2.00
Lemery	1	2.0	2.00
Talisay	1	2.0	1.00
Total	103	295.0	2.86

TABLE 2

Variations in quantities and prices of mandarins marketed, 1951–1952

(based on 103 farms)

ITEM	OCTOBER	NOVEMBER	DECEMBER	JANUARY	TOTAL	AVERAGE EACH MONTH
Total quantity marketed of each variety (kaings")						
Szinkom ...	12,905	16,152	15,010	—	44,067	14,689
King	—	10,569	15,105	12,278	37,952	12,651
Ladu	—	10,805	11,325	10,563	32,693	10,898
Batangas ..	—	13,190	12,680	4,435	30,305	10,102
Total ...	12,905	50,716	54,120	27,276	145,017	36,254
Average quantity marketed of each variety for each farm ("kaings")						
Szinkom ...	268.9	336.5	326.3	—	931.7	310.6
King	—	264.2	359.6	292.3	916.1	305.4
Ladu	—	360.2	377.5	352.1	1,089.8	363.3
Batangas ..	—	471.1	452.8	164.3	1,088.2	362.7
Total ...	268.9	1,432.0	1,516.2	808.7	4,025.8	1,342.0
Percentage of total quantity marketed						
Szinkom ...	8.9	11.1	10.3	—	30.3	10.1
King	—	7.3	10.4	8.5	26.2	8.7
Ladu	—	7.5	7.8	7.3	22.6	7.5
Batangas ..	—	9.1	8.7	3.1	20.9	7.0
Total ...	8.9	35.0	37.2	18.9	100.0	33.6
Average selling price of a "kaing," pesos						
Szinkom ...	6.00	7.50	9.50	—	—	7.66
King	—	13.00	15.00	18.00	—	15.33
Ladu	—	13.50	16.50	19.50	—	16.50
Batangas ..	—	10.00	12.50	15.00	—	12.50
Average .	6.00	11.00	13.38	17.50	—	13.00

TABLE 3

Range of contract price in relation to average area, number of bearing trees, and quantity marketed

CONTRACT PRICE	CLASS AVERAGE	NO. OF FARMS	AVERAGE AREA	AVERAGE NO. OF BEARING TREES	AVERAGE QUANTITY MARKETED FOR EACH FARM REPORTING				
					Ladu	King	Batangas	Szinkom	Total
pesos	*pesos*		*hectares*	*"kaings"*	*"kaings"*	*"kaings"*	*"kaings"*	*"kaings"*	*"kaings"*
Less than 2,000	1,510	4	.63	148	—	485	—	255	740
2,000– 2,999	2,438	14	.75	225	190	436	246	266	1,138
3,000– 3,999	3,470	16	1.31	214	717	303	473	450	1,943
4,000– 4,999	4,323	13	2.65	282	547	320	495	533	1.895
5,000– 5,999	5,227	7	1.28	263	450	474	780	696	2,400
6,000– 6,999	6,460	10	1.15	284	350	608	—	670	1,578
7,000– 7,999	3,463	7	1.35	285	230	665	445	666	2,006
8,000– 8,999	8,300	4	2.37	661	1,622	1,976	890	342	4,830
9,000–10,000	9,564	9	3.27	562	1,463	1,600	913	563	4,539
over 10,000	26,691	19	8.52	1,773	1,669	2,260	2,418	1,865	8.212

TABLE 4

Cost involved in marketing a "kaing" of mandarins, 1951–1952

ITEM	AVERAGE	PERCENTAGE OF AVERAGE RETAIL PRICE	PERCENTAGE OF TOTAL SPREAD
	pesos		
Retail price	13.00	100.00	—
Price received by growers	6.35	48.85	—
Difference	6.65	51.15	100.00
Marketing costs:			
Guarding	.13	1.00	1.95
Picking the fruits	.33	2.53	4.96
Sorting and packing	.15	1.16	2.26
Hauling	.12	0.92	1.80
Transporting	.67	5.16	10.08
Storing (warehousing)	.90	6.92	13.54
Total	2.30	17.69	34.51
Margin covering cost of retailing and profits of middlemen	4.35	33.46	65.41

THE PERFORMANCE OF FOUR VARIETIES OF GLUTINOUS RICE [1]

VALERIANO C. CALMA AND LEONARDO L. GANTIOQUI

A study was made of four varieties of glutinous rice, Dinamulag, Linihim, Malagkit Sungsong, and Paleod, to determine their yield, height, number of bearing culms, flowering period, date of maturity, degree of lodging, susceptibility to pests and diseases, and percentage of milling. The work was conducted from May, 1946, to February, 1947, in the rice fields of the Department of Agronomy, College of Agriculture, Los Baños, Laguna.

MATERIALS AND METHODS

The seeds of Linihim and Dinamulag were obtained in Arayat, Pampanga; those of Malagkit Sungsong, in Biñan, Laguna; and those of Paleod, at the Department of Agronomy, College.

A field of 3,600 square meters of clay loam, which had not been planted to any other crop except rice, was used.

The experiment was of randomized blocks, replicated three times for each variety except Dinamulag, of which there were not enough seeds. The paddies were 300 square meters each and were numbered from 1 to 12.

The seed bed was prepared by the ordinary wet-bed method. The seeds of each of the four varieties of rice in separate gunny sacks were soaked in water for 24 hours, then placed in the shade for 48 hours. Three days later the sprouted seeds were sown at the rate of 30 gantas to every 500 square meters. The variety Dinamulag had very poor germination; hence, about three additional gantas of seeds were sown.

When the seedlings were 28 days old, they were transplanted in the paddies. Two to three seedlings were planted in each of the hills, which were about 25 centimeters apart. Since there were not enough seedlings of Dinamulag for three replications, only one and one-half paddies, covering an area of about 450 square meters, were planted to this variety.

The water in the paddies was kept at the right level to hasten the growth of the plants. The weeds were kept under control until the plants were in the booting stage.

A large flock of red rice weavers, *Lonchura ferruginosa jagori*, came and fed on the maturing grains, but the damage was minimal.

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[1] Central Experiment Station Contribution No. 1642. From the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, October, 1947.

Damage by rats was minimized by the use of arsenic trioxide poison, with grated coconut as bait.

The heights of fifty plants from each plot of Linihim, Malagkit Sungsong, and Paleod were taken at random a week before harvest. Dinamulag was not measured because all of the plants had been damaged by pests. The number of bearing culms in a hill of each variety, except Dinamulag, was also counted by taking 50 plants from each plot at random.

The date of flowering was recorded for each variety as soon as the majority of the plants were in bloom. When the grains of the panicles were full and hard, the plants were considered mature. The date of maturity was recorded.

The degree of lodging of the different varieties was observed from time to time until the plants were mature.

The plants were harvested as they matured. Only the ratoon crops of Dinamulag and Paleod were harvested, by priming, because the plant crops were damaged by pests. Linihim and Malagkit Sungsong matured uniformly and were harvested with a "lilik." The harvest was placed on canvas, spread on the ground right in the field, and then threshed by trodding.

The palay was dried thoroughly, winnowed, measured in gantas, and weighed. The volume and the weight of the empty grains were also recorded. The yield of each variety in cavans to the hectare was determined on the basis of the actual yield of each plot.

Five gantas each of palay from Linihim, Malagkit Sungsong, and Paleod and one and one-half gantas of Dinamulag were dried, further weighed, and later milled. The weight and the volume after milling were recorded and the milling percentage of each variety was determined.

RESULTS AND DISCUSSION

The varieties Malagkit Sungsong, Linihim, and Paleod had fairly good germination in the seed bed, but only very few seeds of Dinamulag germinated. A rag-doll test of Dinamulag gave only 84 per cent germination, whereas the other three varieties gave an average of 93 per cent. Germination was completed a week after the seeds had been sown in the seed bed, at which time there was no conspicuous difference among the seedlings of the different varieties. The seedlings were green, vigorous, and uniform in height. However, at their time of transplanting, or 28 days after they had been sown in the seed bed, there was a great difference in the height of the plants. The average height of the seedlings of Paleod was 47.9 cm.; of Linihim, 43.7 cm.; of Dinamulag, 42.7 cm.; and of Malagkit Sungsong, 37.8 cm. The seedlings of Dinamulag already had nodes.

When the plants were 77 days old, an unusually early booting was noted in some of the plants of Dinamulag. A week later, some of these plants began to flower. The early flowering may have

been due to the fact that the seedlings had already produced nodes at the time of transplanting, indicating that Dinamulag is an early-maturing variety. It was also observed that 82 days after transplanting, some of the plants in all the plots of Paleod were already booting. However, the plants of Linihim and Malagkit Sungsong were still in their active vegetative stage.

According to Ramiah and Dharmalingan,[2] four types of lodging occur in rice. In the first type of lodging, the plant gradually bends over with little or no rupture of the tissue. This commonly happens when the soil is over-fertile and a bumper crop is expected. The first type of lodging occurs only at the end of the season and causes no loss of crop, unless adverse weather conditions prevail at or just before harvest. The second type of lodging is observed in varieties which have very open habits of tillering. There is no rupture of the tissue and crop damage need not be anticipated. In the third type of lodging, which is more general in varieties of short duration, the whole plant falls over. This is probably due to a root system that is superficial and becomes easily displaced. It also happens in directly sown fields, where the seeds are left on the surface of the soil, resulting in a surface root system. The fourth type of lodging, which is the most serious, results from the rupture of the tissues just a few inches above ground level. The weakening of the supporting tissues may be due in part to the fluctuating water level and the consequent alternate wetting and drying.

The writers noted that the lodging of the plants in their work was of the fourth type. Malagkit Sungsong lodged, but not as much as Linihim; Paleod and Dinamulag did not lodge at all.

The insect pests that attacked the four varieties were the stem borer, *Schoenobius incertellus* Walker, and the rice bug, *Leptocorisa acuta Thunberg*. The latter was responsible for the empty grains occasionally found in some panicles. The plants were most susceptible to the attack of rice bugs at the milk stage. The red weaver, *Lonchura ferruginosa jagori*, fed on the grains from the time the plants approached the milk and dough stages till they reached maturity. Rats and bats were suspected of having done considerable damage to the crop. The false smut of rice caused by *Ustilaginoidea virens* (Cke.) Tak. was present in a few panicles, but its damage was negligible.

Dinamulag was entirely destroyed by pests because it flowered the earliest. Paleod also suffered greatly because it attained the milk and dough stages at almost the same time as Dinamulag. These two are early varieties. Malagkit Sungsong and Linihim were the least affected because they flowered and matured at practically the same time as the greater part of the rice crop in the surrounding fields.

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[2] Ramiah, K., and S. Dharmalingan. 1934. Lodging of straw and its inheritance in rice (*Oryza sativa*). The Indian Journal of Agricultural Service 4, Part V: 882–883.

At maturity, Linihim was the tallest, with a mean height of 138.93 centimeters; Malagkit Sungsong, second, with a mean height of 129.56 centimeters; and Paleod, the lowest, with 95.25 centimeters. When the mean heights were statistically compared, however, Linihim was not any taller than Malagkit Sungsong. On the other hand, the difference in height between Linihim and Paleod was highly significant. Malagkit Sungsong is significantly taller than Paleod.

Malagkit Sungsong, with a mean of 17.30, had the greatest number of bearing culms in a hill. There was no significant difference in the number of bearing culms to the hill produced by Linihim and Paleod.

Dinamulag flowered 86.5 days after it was sown in the seed bed. The maturity of this variety could not be determined because of the damage it suffered from pests in its milk and dough stages. Paleod flowered in 92 days and matured in 133.4 days; Malagkit Sungsong flowered in 96 days and matured in 136 days; and Linihim flowered in 101.3 days and matured in 139.6 days.

The yields of the three varieties are shown in table 1. Dinamulag was not included because only a few of its seeds germinated and there were not enough seedlings for the necessary replications. Furthermore, the crop was totally destroyed by pests. Linihim gave the highest yield, outyielding even Malagkit Sungsong, the standard glutinous variety raised in the College and in neighboring towns. Malagkit Sungsong and Paleod did not differ in yield when statistically compared. Linihim gave a mean yield of 32.2 kilograms; Malagkit Sungsong, 13.6 kilograms; and Paleod, 7.0 kilograms to a plot of 300 square meters. Based on actual yield, the computed yield to the hectare of Linihim was 22.95 cavans; Malagkit Sungsong, 10.35 cavans; Paleod, 5.30 cavans; and Dinamulag, 0.86 cavan.

Linihim gave the highest yield because it suffered less damage from pests by maturing at the same time as the rice crop in the surrounding fields. In general, the later the rice matures, the greater is its yield. Linihim matured the latest. Its tendency to lodge at maturity indicated that it produced heavier panicles than either of the two varieties.

Only 3.4 kilograms, or two gantas, of Dinamulag were harvested from the ratoon crop that subsequently developed from the destroyed plant crop. The extremely low yield may have been due to the late transplanting of the seedlings, when they had already formed nodes.

Malagkit Sungsong had the highest percentage of milling, 70.7 per cent. Linihim and Paleod both had 65.4 per cent; Dinamulag had the least, 58.3 per cent.

SUMMARY

1. The heights of Linihim and Malagkit Sungsong did not differ significantly, but both were taller than Paleod. Linihim was the highest with its mean height of 138.93. The mean height of Malagkit Sungsong was 129.56, and that of Paleod, 95.25 centimeters.

2. Malagkit Sungsong, with a mean of 17.30, had the greatest number of bearing culms to a hill. Linihim, with 12.88, was second, and Paleod, with 12.77, last.

3. All of the four varieties were attacked by pests and a disease, but Dinamulag suffered the most and Linihim the least. Linihim lodged heavily, Malagkit Sungsong, slightly, and Dinamulag and Paleod, not at all.

4. Dinamulag flowered in 86.5 days, but its date of maturity could not be determined because it was totally damaged in the milk and dough stages. Paleod flowered 92 days and matured 133.4 days after sowing in the seed bed. Malagkit Sungsong flowered in 96 days and matured in 136 days; Linihim flowered in 101.3 days and matured in 139.6 days.

5. Linihim gave a higher yield than either Malagkit Sungsong or Paleod. There was no significant difference between the yields of the latter two varieties. Linihim gave a computed yield of 22.95 cavans to the hectare; Malagkit Sungsong, 10.35 cavans; Paleod, 5.30 cavans; and Dinamulag, 0.86 cavan.

6. Malagkit Sungsong gave a milling percentage of 70.7; Linihim and Paleod, 65.35 each; and Dinamulag, 58.3.

TABLE 1

Comparative yield of clean palay in kilograms of the three varieties

PLOTS	VARIETIES			TOTAL	MEAN
	Linihim	Malagkit Sungsong	Paleod		
1	29.3	16.2	5.9	51.4	17.1
2	24.1	15.3	4.3	43.7	14.5
3	37.4	9.5	10.8	57.7	19.2
Total	90.8	41.0	21.0	152.8	16.9
Mean [a]	30.2	13.6	7.0		

[a] L.S.M.D. = 11.69

ANALYSIS OF VARIANCE

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5 per cent	1 per cent
Plots	2	32.73	16.36			
Varieties	2	861.34	430.67	16.17	6.94	18.00
Error	4	106.51	26.62			
Total	8	1000.58				

CASSAVA RICE, OR LANDANG[1]

VALENTIN G. CEDILLO

Already well-known to the Filipino housewife are a number of food preparations from cassava (*Manihot utilissima* Pohl.), such as *puto, suman,* tapioca, flour, and *gaplek.* However, cassava rice, or *landang* as the Moros call it, is practically unknown in Christian homes. Moro families generally keep in their homes slabs of grated cassava wrapped in banana leaves or simply a supply of fresh roots which they boil to dryness and serve with fish during meals. Many of them prepare cassava as *suman* and *puto.* But all these cassava preparations do not keep long; hence, they often resort to *landang.* Moro fishermen and pearl divers, especially, who stay out at sea for days, find *landang* ideal provision for their trips since it keeps for a long time and may be eaten without further cooking.

Cassava rice is easy to prepare, keeps long, and is nutritious. If properly prepared, it could become a very substantial substitute for rice and corn. The making of *landang* would make a good cottage industry since the equipment and materials needed are simple and readily available. Small farmers would be able to augment their income and at the same time insure themselves against any shortage of food.

For the benefit of housewives, the methods of preparing *landang* in Jolo are briefly described:

THE GRATER METHOD

Freshly dug roots of either the edible or the poisonous varieties of cassava are peeled and fed into a grater or shredder. For a clean and white product, it is desirable to wash the peeled roots before shredding them. The grated mass is wrapped in jute sacks, placed between two wooden blocks, and pressed until no more juice can be squeezed out. The pressed slabs are piled on top of one another and covered with empty jute sacks to prevent the characteristic blackish discoloration which results from exposure to the open air.

When all the grated cassava has been pressed, the making of pellets, the most tedious process, comes next. The pressed cassava is placed in a winnowing basket (*ligo*), which is whirled counterclockwise so that the pellets are formed centripetally. The size of the pellets depends on the rate of motion and the moisture content of the grated cassava mass being whirled in the winnowing basket. Bigger pellets are produced when the motion is slow and the moisture content is great than when the motion is fast and the moisture content is low. Every now and then, the pellets are passed through

[1] Central Experiment Station Contribution No. 1643.

a sieve. Those that do not pass through are put back into the winnowing basket and whirled again until reduced to the desired size. The pellets are then spread on a mat or G. I. sheet and air-dried a little.

The next step is the cooking of the pellets with hot steam. A medium-sized vat or clay pot may be used for this purpose. Holes about 1/16 inch in diameter are bored at the bottom of a coconut shell. The shell is placed over the mouth of the pot, and the area of contact between the outer surface of the coconut shell and the inner lip of the clay pot is plastered with moist grated cassava to seal the pot. The vapor that cooks the pellets in three to five minutes will pass out only through the minute holes at the bottom of the shell. In case a vat is used, a very fine mesh-screen wire is attached to a circular frame that fits the mouth of the vat. The region of contact between the frame and vat is sealed with moist grated cassava, as in the case of the coconut shell and clay pot combination. The vat is more practical to use for a large volume of preparation.

The cooked pellets are poured into the winnowing baskets and separated individually by hand. The cooked mass should not be allowed to dry out entirely before being separated because some will stick together, resulting in misshapen pellets. The pellets are finally dried in the sun from three to five days depending upon the intensity of sunlight. Kiln drying takes a much shorter time and results in a product of better quality. The method and length of time of drying influence the color of the *landang*. Pearly white *landang* is very attractive and commands a good price on the market.

A few pellets may be opened to find out if the inner portion, especially the center, is already dry. If the *landang* is white, its dryness is much easier to ascertain. Well-dried *landang* shows a characteristic pearly lustre. The pellets should be allowed to cool before they are put in a sack for storage in a cool, dry place. Well-dried *landang* has been found to keep for three to six months before molds develop.

THE SOAKING METHOD

The second method of preparing *landang* from cassava roots requires only an earthen jar or a wooden vessel and water. Metal containers do not make good soaking receptacles because the prussic or hydrocyanic acid of the cassava roots reacts with the metal and produces a poisonous by-product.

The roots are peeled and submerged in fresh, clean water. They should not be out of the water because they become black in no time. The roots begin to soften after five to seven days, depending upon their quantity. To make sure that they do not become oversoaked, they should be examined from the third to the fifth day. When the roots are well soaked, they are macerated and the fibers are removed.

The macerated mass is air-dried before it is made into pellets. As soon as the mass has reached the proper consistency, it should be made immediately into pellets to avoid producing the dark brown to blackish *landang* which is not marketable.

The making, cooking, drying, storing, and preparing for the table of the pellets produced in the two methods are the same.

PREPARING LANDANG FOR THE TABLE

Landang may be cooked in plain water or in coconut milk. When cooked in plain water, it is first soaked from 15 to 30 minutes and then cooked just like rice. Because *landang* expands greatly, the cooking water should be about four to six inches above the level of the *landang*. The consistency of the cooked product depends upon the experience and ability of the cook.

If coconut milk is to be used, the *landang* is soaked in water a little longer, that is, from 30 to 60 minutes. By that time the pellets have already attained the maximum swelling. The coconut milk is then poured into the pot, usually up to two or three inches above the *landang* level. After boiling, the pellets are allowed to dry thoroughly before being served.

EXPERIMENT ON THE PREPARATION OF CASSAVA RICE

Although *landang* is a household stand-by in Sulu, no work has been done to find out the advantages and disadvantages of each method discussed in the foregoing pages. To ascertain which is the better of the two methods, a simple experiment was conducted in the College of Agriculture at Los Baños, Laguna, from January to the summer of 1952 to determine the percentage from a given quantity of roots, the labor requirement, the quality, and the food value of *landang* produced by each method.

Procedure

Percentage of peelings and butt ends to the total fresh weight. The peelings and butt ends from the roots prepared by the grater method weighed 3.1 kilograms, or 31 per cent of the total weight; those from the roots prepared by the soaking method, 2.5 kilograms, or 25 per cent. The average weight of the peelings and butt ends in both methods was 28 per cent.

The grater method. Ten kilograms of freshly dug cassava roots were peeled, washed, and grated with a small piece of rectangular G. I. sheet perforated by a 2½-inch nail. The refuse after grating weighed 200 grams. The grated mass, which was wrapped in a jute sack and whose juice was expressed by using two wooden blocks, was found to contain 45.62 per cent moisture. Two days later the moisture content decreased to 41.33 per cent which was the moisture content when the pellets were made.

The juice was decanted from the precipitate which may be used as flour. It weighed about 100 grams when thoroughly dried. The grater method, therefore, has an advantage over the soaking method in that flour is produced as a by-product.

Before making the pellets, the cassava slabs were pounded with a native pestle and mortar in order to make the grain and texture of the mass finer. A fine mass is essential for a better quality of *landang*. During the making of the pellets, it was observed that the mass was quite dry so that a small amount of water was sprinkled over it every now and then to maintain the proper consistency. Pellets are more difficult to form when the mash is too dry, but become bigger when the mass is too moist. The right moisture content is between 45 and 50 per cent.

The pellets were air-dried before cooking to reduce their moisture content to about 41 per cent. If the pellets are too dry, cooking is not uniform and whitish streaks are noticeable within the pellets; if too wet, the cooked pellets are soft and sticky, making the separation rather difficult.

The pellets were sun-dried from three to five days depending upon the intensity of the heat. Pellets for long storage should contain from 13 to 14 per cent moisture or even lower; they will keep from six to twelve months without deteriorating provided they are stored in a cool, dry place.

The soaking method. In this method, 7.5 kilograms of peeled and washed cassava roots were soaked in fresh, clean water in two earthen jars. The level of the water was kept about an inch or more above the roots in order to keep them from direct contact with the atmosphere. Although the discoloration which results from exposure of the roots to the air does not render the *landang* unfit for food, it makes the product less attractive for the market.

Every night for seven days, the water in the jars was changed to prevent foul odor from developing. On the seventh day the roots were soft enough to be easily crushed in the palm of the hand. All the crude fibers and the piths, weighing 150 grams, were removed from the macerated mass. The mass was then wrapped in a jute sack and expressed of its juice with two wooden blocks to which a pressure of 100 to 120 pounds was applied. After the juice had been expressed, the moisture content of the mass was from 45.56 to 45.67 per cent, or an average of 45.62.

One disadvantage of this method is that the expressed juice does not contain any appreciable amount of starch.

As in the grater method, the mass was pounded before the pellets were made. Pounding the macerated mass is very important in this method as some of the cassava flesh is still intact. A small amount of water also had to be sprinkled over the mass while the pellets were being made. The pellets formed were first air-dried before they were steam-cooked. They should contain about 41.33

per cent moisture during the cooking. If the moisture is right, the pellets easily separate or crumble as soon as they are removed from the coconut shell and spread on the mat. The cooked pellets were dried in the sun for three to five days. The moisture content of the pellets after this period was from 13.57 to 13.92 per cent. The dry pellets should be allowed to cool off sufficiently before they are put into permanent containers to avoid sweating in the containers.

DISCUSSION OF RESULTS

Labor requirement. The weighing, peeling, and washing of the ten kilograms of cassava roots used in the grater method required an hour; grating, wrapping, and expressing the juice, one hour and 45 minutes; pounding the mass and making the pellets, about two hours; cooking and separating the pellets, nearly three hours; drying and picking over a three-to-five-day-period, one-half to one hour.

In the soaking method, the weighing, peeling, washing, and putting of the roots into the earthen jars required 1½ hours; changing of water every night for seven days, about 30 to 50 minutes; removing the water, macerating the mass, expressing the juice, pounding, and making the pellets, about two hours; steam-cooking, separating the pellets, drying, and storing, three to four hours.

It would appear that the labor requirement in both methods is rather high. The problem is to reduce this requirement to the minimum by employing improved mechanical devices and by working on a large-scale basis. It is a tested economic principle that labor cost can be lessened greatly by increasing the volume of raw materials and utilizing better mechanical appliances.

The quality of landang. The quality of *landang* is influenced by a number of factors: age of roots, time, air and moisture, and, of course, the size and uniformity of the pellets. Generally speaking, the fresher the roots, the faster they are prepared, and if the pellets are correctly air-dried, that is, if they contain only the right amount of moisture when they are steam-cooked, and then dried immediately under a strong sunlight, the *landang* produced possesses a pearly-white color. Otherwise, they acquire a brownish-red color. If the pellets are uniformly shaped and are no bigger than mungo seeds, they look more attractive and, consequently, command a better price on the market.

Landang produced by the grater method is not as glossy as that produced by the soaking method, probably on account of the fact that the starch is not removed in the latter method.

Apparently, cassava rice produced by the soaking method is comparatively lighter in color. Besides being glossy and smooth, the pellets are more compact and seem to produce a glutinous-like effect when eaten. However, this is largely a matter of personal taste and varies among different individuals.

Percentage return from each method. The 7.5 kilograms of peeled cassava roots prepared by the soaking method produced approximately three kilograms of *landang*. The percentage based on the weight of ten kilograms of fresh roots is 30 per cent; based on peeled roots, 40 per cent.

Native varieties yield, on the average, 15,220 kilograms of roots a hectare; and foreign varieties, from 16,140 to 38,820 kilograms, or an average of 27,480 kilograms. In the soaking method, the computed yield of *landang* from one hectare using native varieties as the basis is 4,566 kilograms; using foreign varieties, 8,244.

Ten kilograms of fresh roots in the grater method produced only 2.95 kilograms, or 29.5 per cent. This disparity in yield of the two methods is probably due to the fact that in the grater method, there are more waste products and some amount of starch is removed. The computed yield of *landang* from a hectare using the native varieties would be 4,489.9 kilograms; using the foreign varieties; 8,106.6.

Food value. The average chemical composition of some cassava varieties studied in the College of Agriculture follows: [2]

CONSTITUENT	PERCENTAGE
Edible portion	81.40
Moisture	63.80
Ash	1.44
Proteins	0.96
Fats, ether extract	0.26
Hydrocyanic acid	0.02
Crude fiber	0.85
Starch	27.65
Other N.F.E.	5.04
Calorific value per 100 grams	1,403.00

The average chemical compositions of *landang* prepared by the two methods were analyzed in the Department of Agricultural Chemistry as follows:

	GRATER METHOD	SOAKING METHOD
	per cent	*per cent*
Moisture	14.2	13.75
Crude proteins	2.41	1.22
Crude fats (ether extract)	0.26	0.32
Carbohydrates	80.79	81.02
Crude fibers	1.68	1.87
Ash	0.65	1.82
Calorific value per 100 grams	335.00	332.00

The average chemical compositions of some Philippine foodstuffs determined in the College of Agriculture are as follows: [3]

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[2] UICHANCO, L. B., AND FRANCISCO M. SACAY. 1949. Philippine Agriculture. Vol. I. Field Crops. College of Agriculture, University of the Philippines.

[3] ADRIANO, F. T. 1925. The proximate chemical analysis of Philippine foods and feeding stuffs. Philippine Agriculturist 14: 57–91.

	CORN SEED (Yellow) AIR-DRY	BIGAS PATAY (dead rice)	APOSTOL (L) 180 [a]	BINICOL (U) 147 [b]	MACAN (L) 128 [a]
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Ether extract	4.47	0.60	1.10	2.28	0.64
Ash	2.61	0.91	1.50	1.36	1.29
Protein	8.90	9.34	8.35	7.73	7.59
Crude fiber	2.86	0.38	0.92	0.73	0.54
Carbohydrates	67.28	—	76.74	75.05	76.75
Food value per 100 grams	353.91	—	359.099	366.182	351.746
Moisture	13.88	13.63	11.39	12.25	13.19

[a] (L) lowland rice.

[b] (U) upland rice. The figures after each variety of rice indicate the number of days from planting to maturity.

SUMMARY

The most important finding in this experiment is that *landang* compares favorably with corn and rice as to food constituents and calorific value for every 100-gram sample. Although corn and rice contain more proteins, *landang* has a greater amount of carbohydrates. From the nutritive point of view *landang* can very well become a good substitute for corn or rice during hard times.

The most striking difference between the *landang* prepared by the grater method and that by the soaking method lies in the protein content. The *landang* from the grater method contains 2.41 per cent protein, whereas that from the soaking method, 1.22 per cent. The discrepancy is perhaps due to the effect of soaking and washing in the soaking method. The calorific value for every 100 grams is also different in each process; it is higher in the grater method.

THE SHORTEST TIME FOR OBTAINING ACCURATE BODY TEMPERATURES OF ANIMALS[1]

VALENTE VILLEGAS

One minute saved in determining the body temperature of a single animal is inconsequential, but when a series of readings of body temperatures of many animals is to be taken, either alone or coupled with other observations, then the question, "Are there statistical differences in the readings of the body temperatures of animals taken at durations of one, two, and three minutes?" requires an answer based on a large number of readings. Hence, this work was conducted in the Department of Animal Husbandry from August 30, 1950, to September 20, 1951.

PROCEDURE OF THE STUDY

Five male and five female rabbits of the common white kind, five Philippine steers, five Philippine cows, and five Berkjala sows were used. At the start of the experiment the rabbits had an average age of 30 months; the youngest was 29 months old, and the oldest, 32 months. The steers had an average age of 11 years, and the cows, 9 years. The sows were from 18 to 43 months of age, the average being 26 months.

Two veterinary clinical thermometers, one manufactured by Sussex Eisele and Company and the other in Faichney, Watertown, New York, were used. The first was 13.3 centimeters long and the second, 10.6 centimeters. Both were graduated in units of 0.2 Fahrenheit and had a maximum reading of 108°F. In the taking of the body temperature, the thermometer was inserted into the rectum of the animal, leaving only 1 to 1.8 centimeters outside. The temperatures of the animals were taken in succession for one and three minutes and for two and three minutes.

RESULTS

Readings at durations of one and three minutes

The Philippine steers and Berkjala sows were used for determining whether or not there are differences in the readings of body temperatures when the thermometers are left in the animals for one minute and three minutes. Of the 160 readings made on Philippine steers, 80 were taken for one minute and 80 for three minutes. The readings were made in the morning and in the afternoon. The mean body temperature for the one-minute readings was 101.01°F., and for the three-minute readings, 101.07°F. The value of experimen-

[1] Central Experiment Station Contribution No. 1644. Read before the Los Baños Biological Club on August 31, 1951.

tal *t*, which was 0.8178, is far below the 2.609 of tabular *t* at one per cent level, showing an insignificant difference.

Of the 198 readings made on the Berkjala sows, 99 were recorded after one minute and 99 after three minutes. All readings were taken in the morning. The mean temperature for one-minute readings was 102.6°F. and for three minutes, 102.8°F. The value for experimental *t* at one per cent level was 1.55. Since the tabular value is 2.601, the difference between the readings for the two durations is not significant. As determined from the readings for both durations, the mean body temperature of Berkjala sows was 102.7 ∓ 0.89°F.

Readings at durations of two and three minutes

The rabbits and Philippine cows were used for testing the significance of the readings of the body temperature when the thermometer had been in the rectum of the animals for two minutes and for three minutes. The same number of readings, 164, was taken for the two-minute and three-minute durations. The readings were taken in the morning. A comparison of the two-minute readings in both sexes showed that the mean temperature was 103.4 ∓ 0.40°F. for the males and 103.3 ∓ 0.76°F. for the females. The experimental *t-value* was 0.16, whereas the tabular *t-value* was 1.979 at five per cent level, indicating that there was no significant difference between the temperature of the males and the females when the thermometer was exposed for two minutes. When the thermometer was allowed to remain for three minutes, the mean temperature was 103.4 ∓ 0.34°F. in the males and 103.5 ∓ 0.68°F. in the females. The experimental *t-value* of the difference was 0.18, whereas the tabular *t* was 1.979 at five per cent level, also indicating an insignificant difference.

The mean temperature of both sexes when the thermometer was exposed for two minutes was 103.48°F. and for three minutes, 103.53°F. As shown by the results of these tests, the normal body temperature of mature common white rabbits is 103.64°F.

Among the Philippine cows the 80 temperature readings taken morning and afternoon after the thermometer had been exposed for two minutes and 80 after three minutes showed a mean of 101.5°F. ∓ 0.45°F. for the two-minute duration and 101.6°F. ∓ 0.41°F. for the three-minute duration. As the experimental *t-value* of the difference was 0.23 and the tabular *t-value*, 1.976 at five per cent level, there was no difference in temperature readings after two minutes and three minutes.

CONCLUSION

From this investigation, it is clear that the body temperature readings are the same whether the thermometer is allowed to remain

in the rectum of the animal for one minute, two minutes, or three minutes. The practice of leaving the thermometer in the body of an animal for three minutes is unnecessary. However, it is recommended that the thermometer be kept in the rectum for two minutes to make certain that it has been there for at least one minute.

BODY TEMPERATURES OF SHEEP AND GOATS [1]

VALENTE VILLEGAS

In order to establish the norms for the body temperatures of sheep and goats in the Philippines, a study was conducted in the Department of Animal Husbandry, College of Agriculture, Los Baños, Laguna, from June 18, 1949, to January 4, 1952.

Fifteen grade Shropshire sheep, five males and ten females, and 15 Philippine goats, four males and eleven females, all from the Department of Animal Husbandry, were used. The male sheep had herd numbers 2, 43, 45, 58, and 59; the ewes, S2, 8, 11, 21, 24, 31, 33, 35, and 40; the male goats, 1, 100, 114, and 117; and the does, C1, Y6, Y10, Y12, Y23, 3, 22, 30, 35, 49, and 54. Of the male sheep, three were entire and two were castrated. Of the male goats, one was entire and three were castrated. The male sheep, at the start of the work, had an average age of 27.3 months; the ewes, 30.2 months; and the male goats, 25.9 months. One doe was medium in age; the rest of the does had an average age of 39.9 months.

The animals were housed in raised barns with slatted wooden floors. In the daytime, weather permitting, the animals were grazed in the pasture except at midday when they were kept in their respective barns for about two hours. At night they were confined in the barns and fed concentrates. In inclement weather, the animals were given soilage and concentrate in the barns. They were supplied with water and salt in the barns at all times.

A veterinary clinical mercury thermometer, 13 centimeters long and graduated into 0.2 units Fahrenheit up to 108°, was inserted into the rectum of the animal as deeply as possible, leaving an average length of 2.3 centimeters outside the anus. The readings were taken between one and two o'clock in the afternoon, except for a few which were taken at about ten o'clock in the morning.

To establish the normal body temperatures of sheep and goats, 148 readings among the male sheep, 130 among the ewes, 137 among the male goats, and 130 among the does were taken. To determine the difference in body temperature between individual animals, 130 readings were obtained among the male sheep, 120 among the ewes, 104 among the male goats, and 96 among the does.

For the difference in body temperature between the sexes, 148 readings were taken among the male sheep and 130 among the ewes, 137 among the male goats and 130 among the does. Sixty readings were taken among the sheep and 96 among the goats to find out the difference in body temperature between the sexes at different months of the year.

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[1] Central Experiment Station Contribution No. 1645. Read before the Los Baños Biological Club on October 31, 1952.

RANGES IN BODY TEMPERATURE

The minimum body temperature of the male sheep was found to be 101.4°F. (38.56°C.) and the maximum, 105.0°F. (40.56°C.) In the ewes the range was from 101.8°F. (38.78°C.) to 105.2°F. (40.67°C.)

The body temperature of the male goats ranged from 101.0°F. (38.33°C.) to 104.9°F. (40.5°C.) In the does the range was from 101.0°F. (38.33°C.) to 104.5°F. (40.27°C.).

INDIVIDUAL DIFFERENCES IN BODY TEMPERATURE

The differences in body temperature among the individual male goats were significant excepting that between Nos. 1 and 117. The computed F was 25.15; the tabular F at 1 per cent, 3.98. The least significant mean difference was 0.258. There was no difference in body temperature among the individual does. The computed F was 0.299, whereas the tabular F was 5.75 at 1 per cent level.

Similarly, there were significant differences in body temperature among the individual male sheep except between Nos. 58 and 59. The computed F was 13.96; the tabular F, 3.47 at 1 per cent. The least significant mean difference was 0.237. As in the does, the body temperatures of the individual ewes did not differ. The computed F was 0.255, which is less than the tabular F of 4.41 at 1 per cent level.

DIFFERENCES IN BODY TEMPERATURE BETWEEN SEXES

There was no difference in body temperature between male sheep and ewes. The t value was only 1.5348; the tabular t was 2.592 at 1 per cent level.

The difference in body temperature between male goats and does was significant. The t value was 4.9350, whereas the tabular t was only 2.592 at 1 per cent level.

MONTHLY DIFFERENCES IN BODY TEMPERATURE

The differences in the body temperatures of the sheep from month to month were not significant. The temperature from June to November, however, was significantly different from that from December to May.

The body temperature of the goats was statistically the same throughout the year except in May and September when it was significantly lower than in any other month. The body temperatures for May and September were the same. Those for February and October differed significantly from each other.

DIFFERENCES IN BODY TEMPERATURE BETWEEN SHEEP AND GOATS

There was no significant difference between the body temperatures of the male sheep and the male goats. The t value was 1.2132, which is lower than the tabular t of 2.592 at 1 per cent level. In the females of both classes of animals, however, there was a signi-

ficant difference in body temperature. The t value (4.3563) was greater than the tabular t (2.609) at 1 per cent level.

NORMAL BODY TEMPERATURES OF SHEEP AND GOATS

The mean body temperature of the male sheep was 103.19 $\mp$ 0.047°F. (39.55°C.) and that of the ewes, 103.07 $\mp$ 0.063°F. (39.48°C.). Udall (1922)[2] reported the range of body temperature in sheep to be from 102.2°F. (39.0°C.) to 104.9°F. (40.5°C.), the average being 103.4°F. (39.67°C.). Malkmus' (1944) figures were 39.0°C. to 40.5°C. Dukes (1947)[4], citing Clawson, stated that the range was from 100.9°F. to 103.8°F. (38.3°C. to 39.9°C.), the average being 100.3°F. (39.1° C.).

The mean body temperature of the male goats was 103.10 $\mp$ 0.057°F. (39.50°C.); that of the does, 102.68 $\mp$ 0.062°F. (39.27°C.). According to Malkmus, the normal body temperature of the goat ranges from 39.0°C. to 40.5°C. Damant, as cited by Dukes in 1947, gave 10.8°F. (39.9°C.) as the average body temperature, the range being from 101.7°F. to 105.3°F. (38.7°C. to 40.7°C.).

SUMMARY

1. The range of body temperature in the male sheep was from 101.4°F. (38.56°C.) to 105.0°F. (40.56°C.) and in the ewes, 101.8°F. (38.78°C.) to 105.2°F. (40.67°C.). In the female goats, the range was from 101.0°F. (38.33°C.) to 104.90°F. (40.5°C.) and in the does, from 101.0°F. (38.33°C.) to 104.5°F. (40.27°C.).

2. The normal body temperature of the male sheep was 103.19 $\mp$ 0.047°F. (39.55°C.) and that of the ewes, 103.07 $\mp$ 0.063°F. (39.48°C.). The normal body temperature of the male goats was 103.10 $\mp$ 0.057°F. (39.50°C.) and that of the does, 102.68 $\mp$ 0.062°F. (39.27°C.).

3. There were significant differences in the individual body temperatures of the male goats and the male sheep, except between a pair of animals in each class. The individual temperatures of the ewes and the does did not differ. The temperature difference between the sexes was significant in the goats but insignificant in the sheep. Except during certain months, the body temperatures of sheep and goats were practically similar throughout the year. Male sheep and male goats showed similar body temperatures, but the females of both classes did not.

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[2] UDALL, D. H. 1922. Veterinarian's handbook of materia medica and therapeutics. 180 p. New York: The Macmillan Co.

[3] MALKMUS, B. 1944. Clinical diagnostics of the internal diseases of domestic animals. Revised. 311 p., 71 fig. Chicago: Alex Eger, Inc.

[4] DUKES, H. H. 1947. The physiology of domestic animals. xii + 817 p., 184 fig. Ithaca, New York: Comstock Publishing Co., Inc.

COLLEGE AND ALUMNI NOTES

The following students qualified for the honor roll at the close of the first semester: Jose O. Juliano, Ibarra S. Santos, Orlando J. Sacay, Pedro B. Escuro, Concepcion L. Valera, Rodolfo M. Ela, Fernando A. Bernardo, Severino R. Santos, Jr., Lito L. Calo, Verden C. Dañgilan, Amador D. Yñiguez, Alejandro M. Catambay, Jr., Elvira B. Manzanilla, Romeo A. Obordo, Sotero I. Albano, Jr., Rufino D. Ayaso, Jr., and Marcos R. Vega, Jr.

Of the 17 students who are included in the honor roll, seven (41 per cent) are graduates of the U. P. Rural High School. Graduates from this school comprise only nine per cent of the total enrollment.

Mr. Pablo B. Flores, instructor in the Alaminos High School, Laguna, observed agricultural classes in the Rural High School. He secured information concerning methods in training prospective farmers.

The student body of the College held a Christmas dance on December 22, 1951. Prizes donated by faculty members were awarded to winners in the different contests. Mr. Rodolfo C. Ylarde is the president and Dr. V. C. Calma, the adviser of the organization.

The Rural High School student body organization held its Christmas program and dance on December 19, 1951. The program consisted of songs, recitations, and vernacular poems. Christmas gifts were distributed to the students.

The pupils of the Maquiling School held their Christmas program on December 20, 1951. In addition to songs, folk dances, and recitations, an operetta, "The Toy Shop," was presented. The program ended with the distribution of Christmas gifts donated by the Maquiling Ladies' Club.

The Beta Sigma fraternity held a Christmas program at the Agricultural Chemistry Lecture Hall on December 15, 1951. The fraternity distributed gifts to the children of the College laborers. Mr. Rodolfo Ylarde is the president and Dr. D. L. Umali, the adviser of the fraternity.

The Upsilon Sigma Phi fraternity held a party and dance on December 15 at the Seniors' Social Garden. Mr. Jose O. Juliano is the Illustrious Fellow of the fraternity and Dr. Faustino T. Orillo, the adviser.

Dean L. B. Uichanco, '15, was awarded a medal and diploma of merit for meritorious service in the field of higher education at the rites held at the Malacañan Social Hall on December 16, 1951. The awarding of medals, which was done by President Elpidio Quirino, closed the celebration of the golden jubilee of the Philippine educational system.

Prof. Jose Q. Dacanay, '15, accompanied to the campus his students taking agricultural economics at Far Eastern University, on December 9, 1951. The students visited the different projects of the College.

Mr. Albino P. Varona, '29, of the Department of Agricultural Economics of the College, gave the students a lecture on the elements of success in farming.

Mr. Teofilo S. Eugenio, '50, and the former Miss Carmen R. Alcaraz were joined in holy matrimony at the San Marcelino Church in Manila on December 22, 1951. Mr. Eugenio is an instructor in agronomy, and the bride is an instructor in home economics in the Rural High School.

Messrs. Eugenio V. Mendoza, '48, and Mario San Juan, '50, have been appointed instructors in the Departments of Agricultural Botany and of Animal Husbandry, respectively. Mr. Mendoza was formerly teaching at the Marikina High School in Rizal and Mr. San Juan, at the Roxas Memorial Agricultural High School in Guinobatan, Albay.

The College is appealing to its alumni for donation of the following issues of the *Philippine Agriculturist* to complete its collection in the College Library.

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II (1912) nos. 1, 2, 3.
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IV (1915) nos. 1, 4.
VIII (1919) nos. 1, 2.
IX (1921) nos. 6, 7.
X (1921-22) nos. 1, 5, 6, 7, 8, 9, 10.
XI (1922) nos. 1, 2.
XII (1923-24) nos. 1, 5, 9.
XIII (1924) no. 2.
XVI (1927) nos. 1, 5.
XVII (1928) nos. 1, 2, 3, 4, 5.
XXVIII (1930-40) nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, Index.
XXIX (1940-41) nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, Index.
XXX (1941) nos. 1, 2, 3, 4, 5, 6, 7, June-Dec.

In a Christmas letter to President Tan, the Sycip brothers, Alexander, David, and Washington, are offering a scholarship to be given to a deserving and indigent student of the College of Agriculture, for the academic year 1952-1953. The donors decided on this charitable act to remember and honor their father, Dr. Albino Z. Sycip, after whom the scholarship will be named.

With the organization of the Central Experiment Station at the College of Agriculture, a number of positions have been created. Many of these positions have already been filled by the Board of Regents.

Dean L. B. Uichanco, in addition to his duties as dean, serves as Director.

Dr. F. O. Santos, head of the Department of Agricultural Chemistry, has been appointed Assistant Dean and Assistant Director.

Dr. Julian Banzon was designated Assistant Head of the Department of Agricultural Chemistry.

Professor Andres P. Aglibut has been appointed Superintendent of Construction and Associate Professor of Agricultural Engineering; Mr. Clemente Juliano, property officer; Mr. Leon R. Ela, bookkeeper; and Mr. Restituto T. Malabago, chief nurse.

Dr. Gilbert M. Smith, professor emeritus of botany at Stanford University, visited the College on January 5, 1952. He was accompanied by Dr. Eduardo Quisumbing, director of the Philippine National Museum, and Dr. Gregorio T. Velasquez, of the Department of Botany, College of Liberal Arts, University of the Philippines. Doctor Smith is one of the world's leading authorities on algae. He was a professor of Dr. Artemio Manza at Stanford and a professor of Dr. G. O. Ocfemia at Wisconsin.

Dr. F. M. Sacay, of the Department of Agricultural Education, has been requested by the PHILCUSA to serve as consultant in the rural community survey project, which will cover 13 barrios in different sections of the Philippines.

Dr. Rufino Gapuz, dean of the Araneta Institute of Agriculture, was a campus visitor on January 10, 1952. He was accompanied by Mr. Toribio Mercado, '26, professor of agronomy and horticulture in the institute. Mr. Mercado is the author of a pamphlet entitled, "Vegetable Gardening in the Philippines."

At the regular scientific meeting of the Los Baños Biological Club on December 21, 1951, Mr. Rodrigo Guillermo, of the Department of Agricultural Chemistry, read a paper on the utilization of the fruit of *Spondias lutea*. This was followed by the showing of nature study films taken by Professor Brues and Dr. Chapman of Silliman University.

Mr. Arcadio G. Matela, '29, president of the Central Luzon Agricultural College, was awarded on December 16, 1951, by President Quirino, a medal and diploma of merit for progressive and dynamic leadership in the field of education. On January 6, 1952, he was installed as the first president of the Central Luzon Agricultural College in Muñoz, Nueva Ecija.

Dr. Faustino T. Orillo, '44, of the Department of Plant Pathology, married the former Miss Conchita Alonte on January 1, 1952, at the Lady of Sorrows Church in Pasay City. The bride, a pharmacist, is the daughter of the late Fidel Alonte, '30, and is at present with the Department of Agricultural Chemistry.

Mr. Francisco F. Saguiguit, '40, has been appointed provincial agricultural supervisor for Ilocos Norte. He takes the place of Mr.

Alberto D. Santos, '35, who was trasnferred to the Fertilizer Administration.

Mr. Teodoro G. Cadiz has been appointed instructor in the Department of Agronomy. He completed the requirements for the B.S.A. degree in November, 1951.

Md. Vito F. del Fierro, Jr., is now teaching at the Bukidnon National Agricultural School in Musuan, Bukidnon. He completed the requirements for the B.S.A. degree and for the Certificate in Agricultural Education in November, 1951.

Mr. Domingo Tapayan, '41, is the agriculturist of the survey staff at present engaged in making socio-economic surveys of 13 barrios as an ECA-PHILCUSA project.

Mr. Eduardo Paje, '43, was a recent campus visitor. He is with the Roxas Memorial Agricultural School in Guinobatan, Albay, but has been offered a job at the Fertilizer Administration.

Mr. Jose P. Esguerra, '19, a former member of the College faculty, died on December 18, 1951, at his home in Los Baños. Because of failing health, he retired in 1948, after serving the College for about 30 years. Two of his children, Emerita Esguerra, '46, and Manuel Esguerra, '51, are also graduates of the College.

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